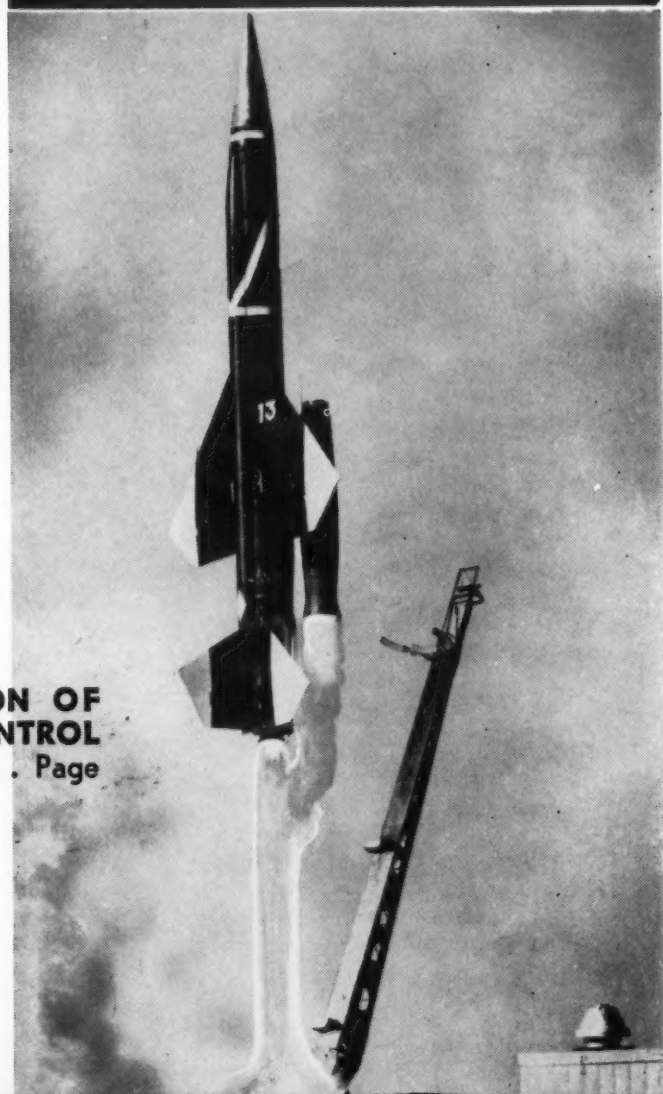


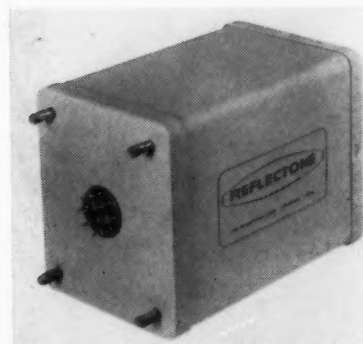
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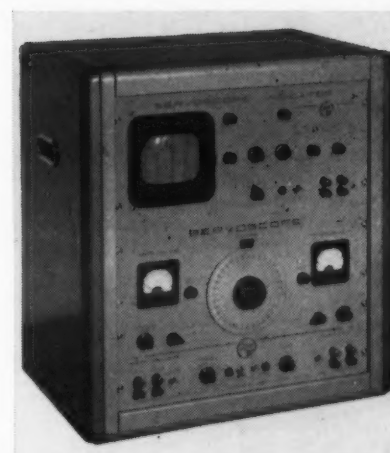
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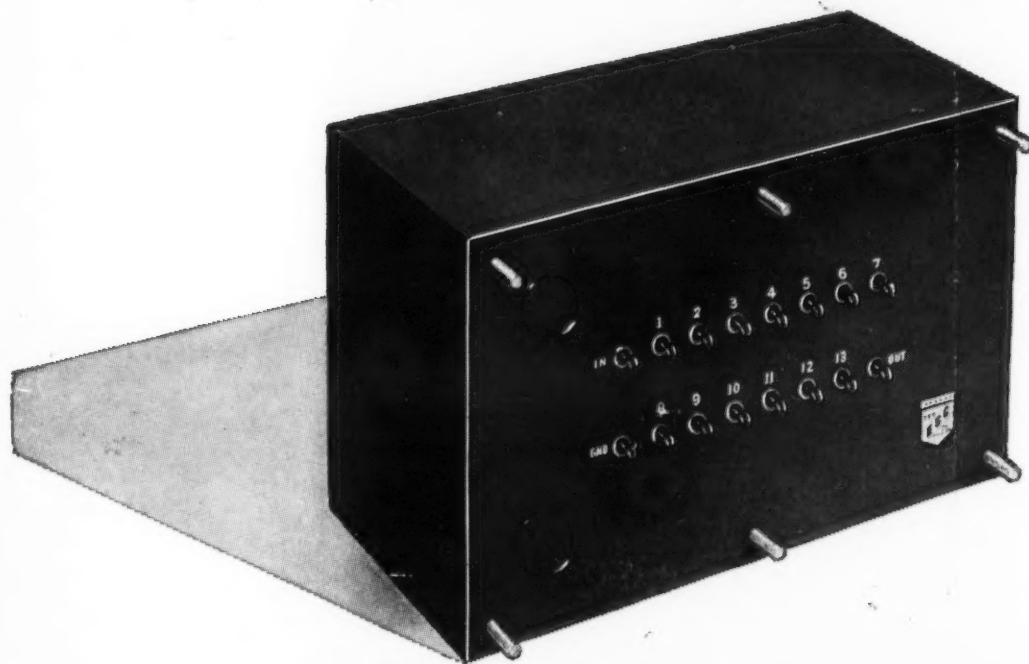
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**Commercial Ferrite Core Delay Line	12 μ s.	0.26 μ s.	41.2	500	23.1	.56	2 db	.0866 db	6.45	.52 μ s.
**Commercial Ferrite Core Delay Line	200 μ s.	4.4 μ s.	74.4	500	22.8	.306	2 db	.0876 db	3.5	8.8 μ s.
**Commercial 1350 Ohm Distributed Line	12 μ s.	0.44 μ s.	77.7	1350	13.6	.175	12.4 db	.911 db	0.192	.88 μ s.
**RG 65 U	8 μ s.	0.31 μ s.	820	950	12.9	.0157	11.5 db	.892 db	0.0176	.62 μ s.
ESC Delay Line Model 51-43	20.3 μ s.	.14 μ s.	115	470	72	.625	2 db	.0278 db	22.5	.28 μ s.

* Merit Factor = $\frac{\text{Pulses In.}^3}{\text{Insertion loss per pulse}}$

**J. R. Anderson, "Electrical Delay Lines for Digital Computer Applications" Transactions of the I.R.E.—June, 1953



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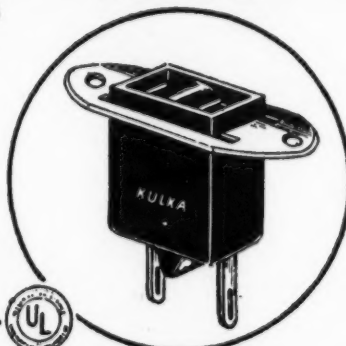
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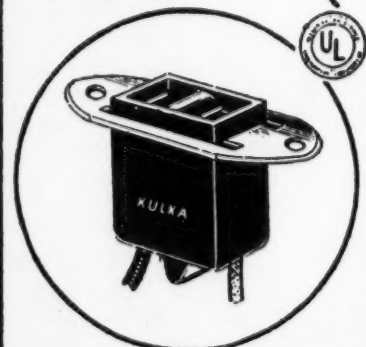
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Servomotors Feature Versatility In Damping Techniques

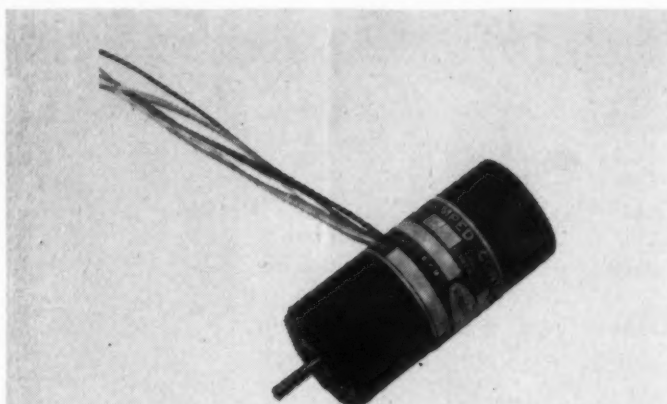


FIG. 1. TYPE II PI-3 Servomotor employs inertial damping.

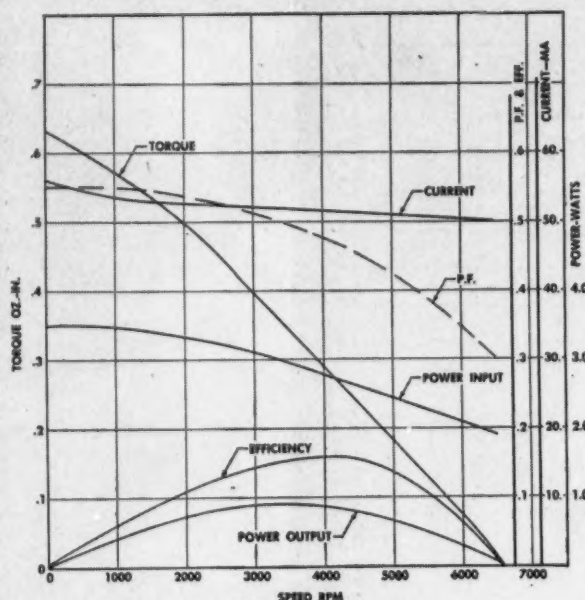


FIG. 2. DYNAMIC CHARACTERISTICS Mechrol Type IPI Servomotor

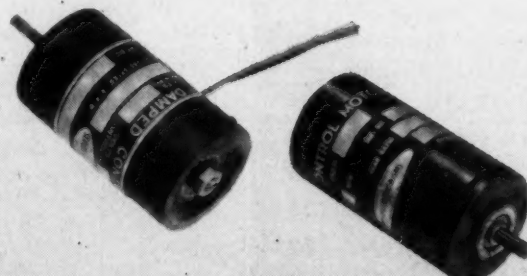


FIG. 3. ADJUSTABLE VELOCITY damping is provided in type IID servo motor (left). Mechrol size 10 hysteresis synchronous motor (right) delivers high pullout torque at 8000 rpm.

BuOrd size 11 and 10 servo motors featuring a variety of damping and control techniques, together with other outstanding performance characteristics, are being produced for missile and aircraft applications by the Mechrol Division of Servomechanisms, Inc., of Westbury, L. I., N. Y. In the size 11 series the Inertially Damped Type 11P illustrated in Fig. 1 is representative. Engineered for a main-phase 115-v 400-cps connection and for control-phase voltages of 40 (series) or 20 (parallel) volts, it delivers a minimum stall torque of 0.60 oz-in with a minimum no-load speed of 6000 rpm. A flywheel with an inertia of 12 gm-cm² furnishes approximately 100 dyne-centimeter seconds of damping in the 11P servo motor. Its rotor has an inertia of 1.40 gm-cm². Other characteristics of the 11P series are shown in Table 1 and by the curves of Fig. 2.

The standard size 11 motor is combined with an integral high performance 400-cycle damping tachometer in a casing only 2 19/32" long to provide a versatile means of system stabilization. Output of the tachometer is 0.5 v per 1000 rpm. Control voltage of this model is standard at 115 v 400 cps, with special voltages available up to 180 v center-tapped.

TABLE 1. ELECTRICAL DATA Type IPI-3 servo motor. Nominal values at rated output.

Part Number IPI-3SI	Main Phase	Control Phase	
		Series	Parallel
Voltage RMS	115	40	20
Frequency	400	400	400
Current MA (at stall) untuned	56	160	320
Input Watts (at stall)	3.5	3.5	3.5
Resistance (stall) ohms	1110	134	34
Reactance (stall) ohms	1720	208	52
Impedance (stall) ohms	2050	250	63
Effective Resistance	3800	450	110
Parallel Tuning capacitor (stall)		1.2	4.8
Power Factor	.55	.55	.55

Adjustable velocity damping is provided in a third size 11 motor only 1 51/64" long (Fig. 3). Damping is accomplished by adjusting the axial screw shown at the rear of the motor. This adjustment varies the position of permanent magnets relative to a low-inertia drag cup fixed to the rotor. The no-load speed of the motor thus can be varied from 5500 rpm down to 3900 rpm. As in the case of other size 11 motors, the stall torque is 0.60 oz-in minimum. Special voltages and integral gearheads are also available with this motor.

Complementing the Mechrol size 11 damped servo motor line is an internally-damped size 10 servo motor with no-load speed of 4000 rpm nominal, 0.30 oz-in torque; also a type 10H hysteresis synchronous motor, shown in Fig. 3.

For more information circle 370 on inquiry card.

MILITARY AUTOMATION

MA

MILITARY TACTICS & AUTOMATION*

THE formation of a military department in the recent Automation Exposition can be regarded as somewhat overdue; because historically, automation had its beginning in the manufacture of weapons for the American Army. Industrial automation is a natural evolution of the assembly-line concept, invented by Eli Whitney to speed the production of muskets and to provide the interchangeability of musket parts—an important contribution to military logistics a hundred and fifty years ago.

Since that early beginning many techniques, now considered classic examples of automation, had their inception in devices initially designed to meet military requirements. Fire-control rangekeepers, taking inputs both from human operators and electrical sensing devices, first simplified and then took over the computation of complex mathematical equations necessary for accurate gun-fire. From these elementary computers have derived the giant automatic scientific and business-type computers of today.

Although labor-saving features of automation strongly influence most industrial automation applications, in military uses this factor is secondary to the accuracy, reliability and operator safety afforded by automation. Military needs have dictated the development of automatic navigational devices, aircraft automatic pilots, and automatic tracking of aircraft and missiles by radar, to name only a few automatic systems which now have important non-military uses. Problems solved in the development of nuclear weapons have given us techniques and hardware for automatic control and testing that are being applied in almost every area of peaceful human endeavor.

However, although military men can justifiably take pride in the peaceful jobs being done by automatic controls, current military interest in automation is little concerned with these past accomplishments. Instead, we are turning to Automation for more help in solving new logistic and tactical problems, some of which have moved into the "Urgent" category just within the year. For instance, the great number of maintenance spares now required by electronic equipment has threatened to bury military supply departments in their own paper work. Appropriately enough—the storekeeping problem is being solved by networks of electronic data-handling computers which provide fresher and more accurate supply data with fewer store-keeper man-hours. While the eventual tax saving will be considerable, it is secondary in importance to the higher degree of military readiness made possible for our ships, planes, and missile-launching pads. Coordinated defense against ballistic missiles can only be achieved by applications of automation more sophisticated than any yet attempted. This increase in system complexity must be accompanied with a new order of component and system reliability, as the activities at Cape Canaveral illustrate.

Another group participating in this session are representatives from industry, who are looking for new opportunities to employ the machines, expert skills, and products of their companies in the national defense effort. It is our mutual interest in these new developments that has brought us to this congress . . . where diversified exhibits and technical instruction by experts in automation are combined.

This afternoon we will hear details of typical uses for automation by each of the three major Armed Services. Control of Naval surface-to-air missiles, coordination of combat information in Army Command Posts, and Air Force requirements for automatic control of aircraft will be discussed by leading engineers in these fields. Also, Mr. Philip Rosenberg, head of the Mechanics Research Dept., American Machine & Foundry Co., in charge of development of the Joliet Arsenal automatic shell-filling machine, will tell us how this new "automation" removes the bottleneck in production of munitions which has plagued us in previous periods of national emergency.

*Opening Remarks, TECHNICAL SESSION IN MILITARY ELECTRONIC & CONTROLS, Fourth International Automation Convention, by CDR Claude O. Morrison, Chairman.

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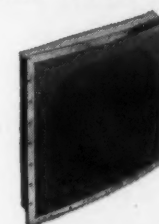
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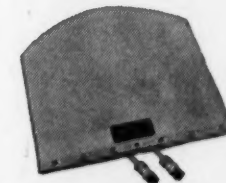
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Evolution of

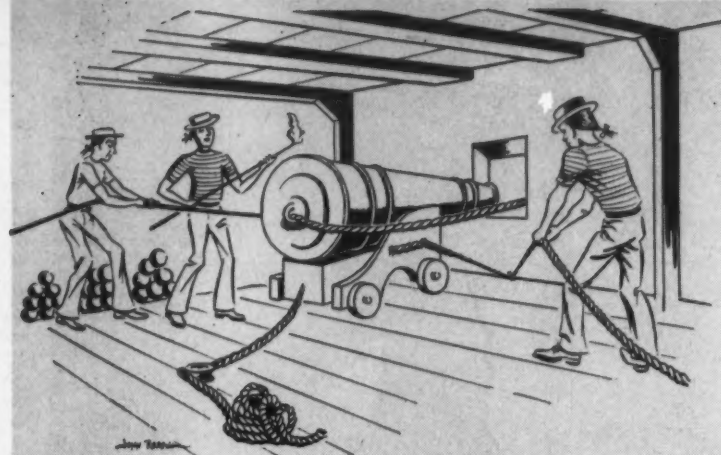


FIG. 1. THEY LOADED "all but the kitchen sink" into the muzzle, waited for the ship's roll, then lit the charge.

FIG. 2. IN WORLD WAR I, Krupp's engineers accidentally discovered shells travelled farther in the thin air of the stratosphere.

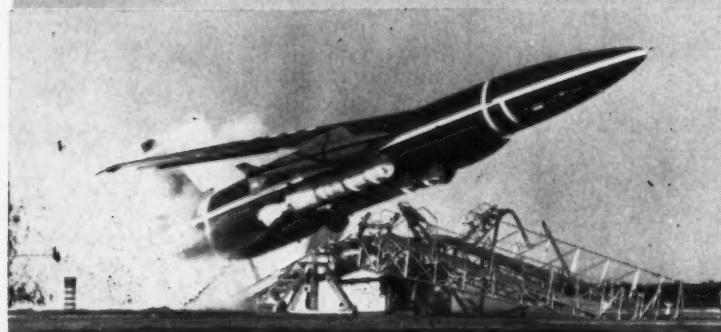
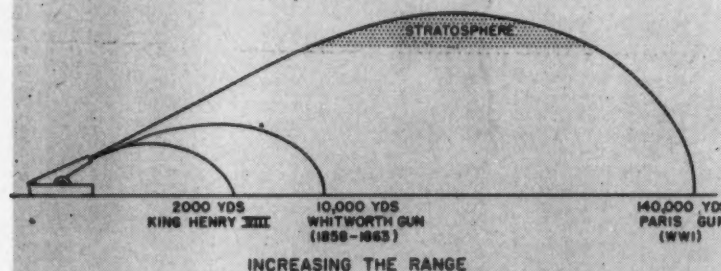
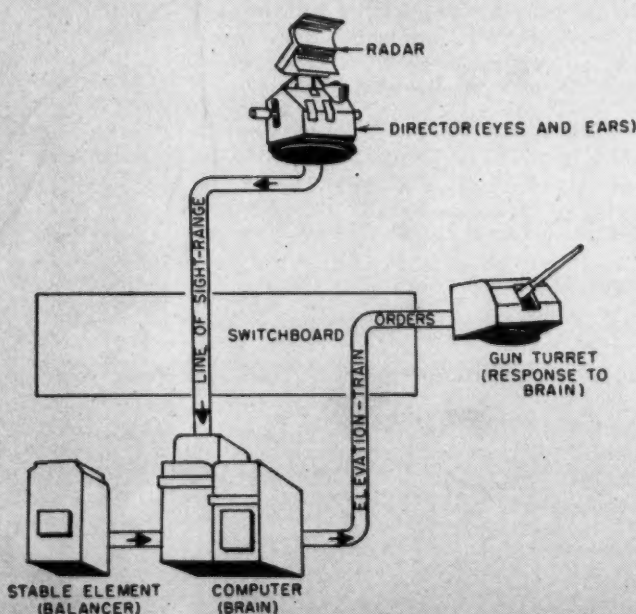


FIG. 3. AIR-FORCE Air-breathing Snark is now operational, long-range guided surface-to-surface missile. (Northrop Aircraft, Inc., Photo)

FIG. 4. STANDARD GUN-FIRING fire control system supplements gunner's skill with radar, stable element, computers, and servosystems.



When the potential destructiveness of fire-power was limited to short-range cannon with solid shot, refinements in accuracy were not required. Just as armor-piercing shells and long-range guns made accurate fire control worthwhile in previous world wars, the tremendous power and range of nuclear weapons now demand fire control systems of fantastic accuracy and complexity.

THEY loaded all but the "kitchen sink" into the gun's muzzle, aimed at the target, waited for the ship to roll upward—then lit the charge. A shower of metal and stones went flying at the enemy's rigging and tore into its hull about 100 yards away (Fig. 1). This, in the time of the Middle Ages, was "Fire Control" at its best.

On land, fire control as such, was not quite so "tough." Here the gun could be put in a fixed position and was not like a ship that continuously moved forward as well as up and down. To gain elevation a field piece could be raised with wedges or mounted on the top of a castle to gain even further elevation. In a castle, elevation and accuracy could be a little better which was one reason castles were built on hills.

Up to the Civil War, range hadn't increased appreciably. The Monitor and Merrimac shot it out at approximately 100 yards during most of their engagement and considering the close range, little damage was done.

From 1900 to the present, fire-control systems have made outstanding progress. The development of accurate large-caliber rifles and high-explosive armor-piercing shells called for refinements in fire control. In rapid succession came components such as the coincidence type range-finders (for measuring distance), rate of change of range projector, range clocks, and the plotting boards. These inventions encouraged still longer ranges and further refinements in accuracy.

About the time of World War I, the idea of increas-

ing range by firing into the stratosphere (an area of lower air resistance) was accidentally discovered when Krupp's engineers in Germany designed a gun to fire a 240-mm shell 105,000 feet, based on assumed density of air at sea level. However, at the test firing, the shell crashed into the backyard of a parson almost 160,000 feet from the gun. The shell had gained almost 55,000 feet because of its easier path through the stratosphere. This new ballistic factor made a range of about 80 miles possible for the Paris Gun during World War I (Fig. 2).

With increases in the size of the gun and in its range, other ballistic factors became important—"drooping" of a long-muzzled gun, curvature of the earth, rotational velocity of the earth while shell is in flight, influence of propellant charge temperature, and diminishing air resistance at high altitudes. (Although the influence of the moon's attraction on the rifle shell was calculated and found unworthy of consideration, this factor may now affect higher-flying missiles.) For rapid computations involving many such factors, mechanical analog computers or "range keepers," were developed.

In 1924 the Navy's most powerful destructive weapon was the 16" shell, with an explosive charge of 50 to 200 lbs of TNT; or the 21" torpedo with 600 to 800 lbs of TNT. The battleship Texas's range was then about 15 miles, but unless she could see the target through her optical range finders and telescopes, she didn't stand much chance of getting a hit. The invention of radar, added to the director, made it possible to detect and accurately measure range

f Fire Control

William J. Gill Jr.

and

Walter A. Murphy



FIG. 6. ARMY'S 75MM Sky-sweeper AA weapon can be remotely aimed, loaded and fired. (U. S. Army Photo)

to the enemy at much greater distances. Also, visibility made no difference.

Increased ranges and air activity during World War II demanded a wide variety of weapons and systems. More flexibility and precision in design and lubrication were needed to permit accurate, rapid anti-aircraft fire (Fig. 3) in South Pacific heat as well as in North Atlantic cold. High-speed targets moving in three dimensions also required changes in fire-control directors. The proximity fuze, which needed no direct contact with the target, was an important fire-control breakthrough in World War II.

Early Rockets and Missiles

Modern rocket research began with Robert H. Goddard of Clark University. He experimented with solid-propellant rockets in 1915, and was the first to effect steering (a means of fire control) by the use of vanes in the exhaust stream. Around 1930 one of his rockets reached a record altitude of 2000 feet and a velocity of 500 miles per hour.

What prompted the development of guided missiles? As long as the destructive effect of warheads was limited by the explosive power of TNT, the cost of propellants and guidance equipment for long-range missiles could not be justified. Invention of the H-bomb with the equivalent of millions of tons of TNT in a small package has made the radar-guided and ballistic missile systems practicable.

In offense, the Air Force has developed guided air-to-ground missiles to extend their bombing accuracy without exposing their planes to increasingly

effective anti-aircraft fire. This trend leads next to the air-breathing Snark (Fig. 3) and the ballistic missiles.

Today's Fire Control

Today's fire control trend is rapidly turning from the free projectile and toward the controlled projectile—or guided missile. This includes the ICBM which uses a pre-set guidance system incorporating a gyro-referenced navigation system.

Fire control, by definition, comprises the entire system of operating and maintaining the instruments, controls, and components of any weapons system that fires a free or controlled projectile. Made up of the sensing or detecting element, a computer, stable element, and turrets, the system picks up, tracks, leads the target, then positions the guns for firing a free projectile (Fig. 4). If a missile is being guided, the system follows both the target and the missile, which it continues to direct to a collision course with the target.

One important reason for governmental support of the International Geophysical Year has been to ascertain the exact location of continents and extent of the oceans. In other words, our fire-control guidance methods are now more accurate than our knowledge of the exact position of possible strategic targets.

Fire control computers differ in complexity with the variables which they must coordinate. The USS Carronade (IFS-1), designed to lay down a rocket bombardment to cover an amphibious landing, uses an electronic computer (Fig. 5) built by the Ford Instrument Company, a division of Sperry Rand Cor-

poration. This ship, although built on an LSM hull, has the firepower of a cruiser. The computer has repeatedly demonstrated its ability to fire with a higher accuracy than can be attained with local control.

With the complexity and vast size of fire-control systems, with their computers, radars, amplifiers, gyros, sights, and drivers, has come the need for instruments to test these systems for accuracy and ruggedness. Some of the calibrating instruments and equipment for the Army's 75mm Sky-sweeper AA weapon (Fig. 6) include clinometers, quadrants, bore-sight telescopes, error recorders, oscilloscopes, meters, and radar test sets.

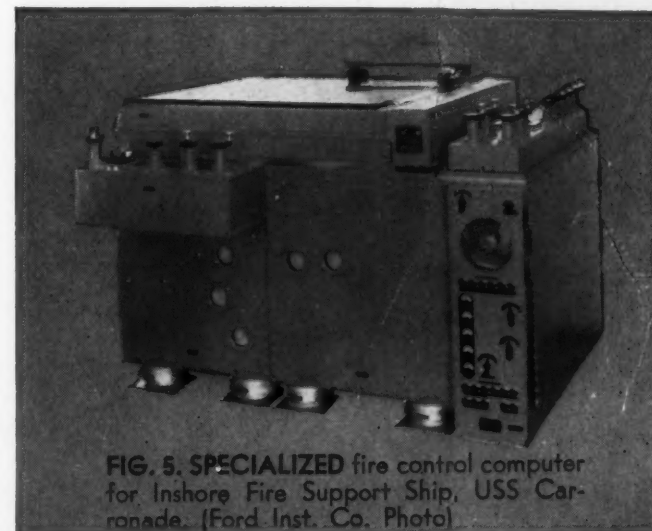


FIG. 5. SPECIALIZED fire control computer for Inshore Fire Support Ship, USS Carronade. (Ford Inst. Co. Photo)



FIG. 7. USS BOSTON (CAG-1) ties in missile radars (shown just forward from Terrier missile launchers) with computers for AA guns. Surface guns in forward turrets are controlled from separate radar and director. (U. S. Navy Photo)

Another piece of equipment just developed which is adding greatly to the effectiveness of land fire control is the Army's new radar mortar locator. The locator's greatest advantage is speed. Within seconds after firing, one or more enemy mortars can be pinpointed by the locator's electronic instruments. This unit is accurate, compact, and mobile. Transportable on two small trailers, it can be set up on a trailer, or with the console in a foxhole 150 yards away. A direct reading of the offending weapon's location is recorded on indicators above the control knobs. Relayed on an artillery battery, the information sets

off immediate counter fire. The unit is intended to reduce Army casualties in future wars.

The Army recently unveiled its field artillery guided missile, Lacrosse, which is to be used in close tactical support of ground troops. It can be fired with the rapidity of a 105 mm howitzer. This short range weapon's guidance system and flight characteristics are classified but the guidance system has been called "unique" and "highly accurate." This missile is of the all-weather, solid-fuel rocket propelled type and includes a truck mounted launcher on a standard Army truck, and a guidance station.

The Army Hawk antiaircraft missile which is effective even against low-flying planes, also uses mobile launchers and guidance systems. Unlike Navy shipboard fire-control components which are solidly secured to decks in separate parts of a ship, the Army stresses mobility and compactness.

The Navy is improving its anti-submarine weapons. Depth charges are now launched via a fire control system. New anti-submarine rockets, as on the destroyer U.S.S. Wilkinson, are mounted on a rocket launcher that can be trained in a near complete circle. Fire control sonar has permitted enemy contact at greater ranges, firing at greater and varying ranges with such control and accuracy that the ship need not turn and race toward the target for the kill. This eliminates the need for many fixed conventional depth charge launchers and racks located about the ship. Nuclear depth charge weapons are also in our arsenal of anti-submarine weapons.

Other Navy developments include the tying-in of Terrier missile radar with gun radar so that one radar can serve not only for missile guidance but as tracking data for the gun computers as well (Fig. 7). Infrared homing is being used by the air-to-air Sidewinder to simplify the terminal guidance problem.

The Air Force has had to make new ballistic tables for its 20mm Vulcan, a revolving type machine gun patterned somewhat after the famous Gatling gun. Increased flexibility of the B-58 bomber turret permits firing across the plane's windstream. This affects the Vulcan's trajectory. A special nose gun, designed to fire straight down at the ground was designed to gather these data.

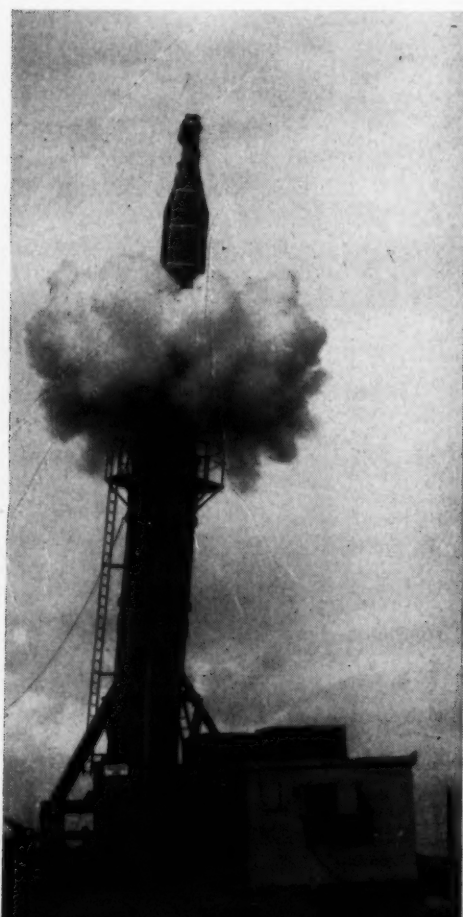
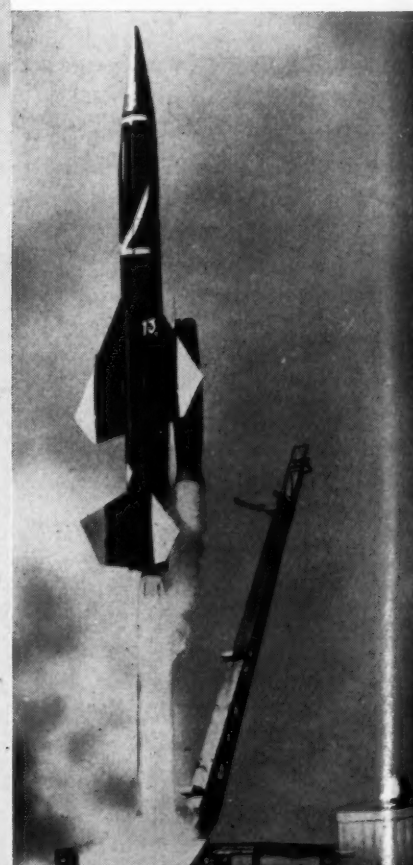


FIG. 8. DUMMY POLARIS is fired from developmental submarine launching system at slight angle to prevent damage to sub in case of misfire. (U. S. Navy Photo)



FIG. 9. AIR FORCE THOR ICBM is successfully fired at Cape Canaveral, Fla. (U. S. Air Force Photo)

FIG. 10. SURFACE-TO-AIR Bomarc guided missile for area defense is now in production. (U. S. Air Force Photo)



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Future Fire Control

It is evident that the future of fire control lies with the "guided missile"—and it will be a decisive factor in the defense of our country. Each of the Armed Forces is affected. The Army has a sizeable start in the missile field, with its Nike-Ajax teams and installations ringing important industrial and military centers across the U. S. Despite the recent Middletown, N. J. disaster we can expect that conversion of these installations to the new Nike-Hercules with its increased range and speed will proceed. The Army also has reported that marked progress is being achieved in the Nike-Zeus, its anti-missile missile.

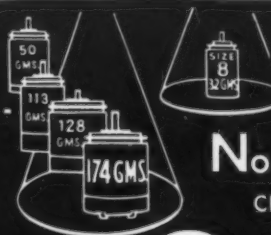
The Navy expects to soon have an intercontinental missile capability by combining its FBM (Intermediate range Fleet ballistic missile), Polaris, with its high-speed, atomic-powered submarine fleet capable of crossing the ocean submerged and of firing its missile without surfacing. The fire-control system on this sub will probably use radio-telescope techniques to insure accurate navigational fixes. (Fig. 8). The Navy has also achieved recognition with its Regulus, Sidewinder, Terrier, Sparrow, and Petrel.

The Air Force, assigned major operational responsibility for an offensive Intercontinental Ballistic Missile, will have available its own Thor (Fig. 9) and the Army-developed Jupiter, both in the intermediate range class. Its long-range Bomarc surface-to-air missile (Fig. 10) for area defense has been successfully tested and is in production. The Convair-built Atlas ICBM has repeatedly flown. Also the Air Force says that its air-to-surface missile, the Bell Aircraft nuclear-warhead Rascal, has demonstrated "500 yd accuracy at long range".

Whereas earlier fire-control systems used localized detection, computing and directing systems applied to a few weapons in a single battery or ship, fire control systems of the future probably will obtain first target data directly from early warning systems widely separated from the anti-missile launching batteries. This trend is already foreshadowed by control of Nike batteries in the SAGE system. Interim and final control guidance radars also probably will be specialized, releasing the early detection radars for their primary duties.

Such an integrated fire control system could be nation-wide and involve tremendous problems in rapid data-transmission and computation if it is to have sufficient capacity to protect against a fusillade of simultaneously released intercontinental ballistic missiles travelling at 1800 mph.

Future fire-control systems which will be needed in outer-space warfare can only be imagined at this time. Russia's achievement in placing heavy satellites in orbit means that another horizon in fire-control development has opened to us—even before we have started to solve the problems of ICBM defense.



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Torque Transmitter	CGC-8-A-7	26	.100	.54	11.8	206	8.5	—	—	—	—	—	—	37	12	54 + j260	12 + j45	80 + j20	30	7	
Control Transformer	CTC-8-A-1	—	—	—	—	—	—	11.8	.087	.21	23.5	411	9	143	24	210 + j690	28 + j114	250 + j73	30	7	
Control Transformer	CTC-8-A-4	—	—	—	—	—	—	11.8	.030	.073	22.5	393	8.5	365	64	470 + j1770	81 + j330	590 + j190	30	7	
Torque Receiver	CRC-8-A-1	26	.100	.54	11.8	206	8.5	—	—	—	—	—	37	12	54 + j260	12 + j45	80 + j20	—	30		
Electrical Resolver	CSC-8-A-1	26	.038	.39	10.8	189	20	11.8	.080	.25	23.5	411	11	230	27	270 + j630	39 + j142	340 + j67	30	7	
Electrical Resolver	CSC-8-A-4	26	.038	.39	26	454	30	26	.030	.23	21.5	376	12	230	170	270 + j630	250 + j330	340 + j67	30	7	
Control Differential	CDC-8-A-1	—	—	—	—	—	—	11.8	.087	.21	11.5	204	9	36	24	38 + j122	28 + j114	47 + j13	30	7	
Vector Resolver	CVC-8-A-1	26	.100	.54	11.8	206	8.5	—	—	—	—	—	37	16.5	54 + j260	19 + j60	80 + j20	30	7		
Vector Resolver	CVC-8-A-1	26	.040	.28	11.8	206	10	11.8	.072	.21	22.5	39.3	10	110	28	177 + j625	41 + j159	215 + j70	30	7	

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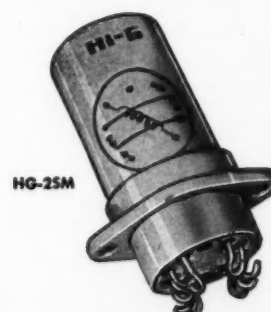
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Dynamic Testing of Servos in Radar Systems

Frank G. Willey

Servo Corporation of America

SERVOS IV

Frequency and phase response characteristics of operating servo systems plotted from test readings made by the Servoscope Servosystem Analyzer check system performance, locate faults and permit computation of corrective networks. The rapidity and ease with which the method described is applied indicate that it may advantageously be used by maintenance and repair crews as well as by design engineers.

AN IMPORTANT component of both search and tracking radars is the control loop which links the sensing end of the system with the indicating end. The heart of the control loop is a servomechanism, that is, a feedback control system in which the controlled variable is mechanical position. In a search radar system this would be the position of a deflection yoke or other type of indicator control. A feedback control system is formally defined as "a control system which tends to maintain a prescribed relationship of one system variable to another by comparing functions of these variables and using the difference as a means of control."

In radar systems the feedback loop commonly combines electrical components like motors, tachometers, potentiometers, and amplifiers with such mechanical elements as gears and shafts to form an electro-mechanical control loop. In such a system the position error of the controlled variable becomes the regulating signal which is amplified and fed back into the system where it regulates the output. Self regulation is a distinctive characteristic of a servo loop which gives it the accuracy required in a radar system.

The design of servos to fit particular tasks is a well developed science but it has not yet reached the point where performance can always be accurately predicted in advance. In spite of careful planning and design much time can be lost when equipment does not meas-

ure up to its theoretical performance and the designer must retrace his work to find the difficulty. Fortunately much of this delay can be avoided by the use of proper test equipment which is now available to perform in minutes an analysis which could take days or even weeks by "haywire" methods. Another advantage of modern test equipment is that it furnishes test results in a form directly usable by both the designer and the trouble shooter in the field.

Types of Radar

While a *search radar* scans the skies at constant velocity, the deflection yoke of its PPI scopes is rotated in exact synchronism by a servo loop in order to display an undistorted picture from which angular fixes can be read with accuracy. *Tracking radars* use servo control loops in both azimuth and elevation to follow the position of a moving target with unerring accuracy so that intercept flights, gun directors, or counter-missile guidance systems can guarantee a high percentage of "kills."

Search Radar Servos

A common servo system for search radar PPI use is of the "two speed synchro" type shown in Fig. 1. The "one speed" synchro provides signals to the servo to drive the PPI deflection yoke to a position roughly corresponding to the antenna azimuth position. An automatic switch-over circuit then switches

control to the second pair of "high speed" synchros, which are commonly geared at 15, 25, 27, 33, or 36 times the speed of the antenna for high final precision. During normal operation, the "high speed" synchros are in control at all times.

Since the function of this servo is to follow accurately an input signal which is moving at constant velocity, the error angle between the PPI yoke and the antenna while the antenna is revolving normally must be small. This error may be measured with a voltmeter or a recorder as indicated in Fig. 1. If it is excessive, or is erratic beyond desired limits, several courses are possible.

1. If the lag is constant and uniform, it may be compensated for by advancing the receiving synchro a corresponding angle in its mount.

2. The servo amplifier gain adjustment may be increased to reduce lag, or decreased to reduce instability or oscillation.

3. If neither of the above methods provides an immediate solution, a dynamic analysis or "frequency response test" of the servo, as described later in this article, should be performed to obtain data needed for correction of the design.

Tracking Radar Servos

Tracking radars employ servos to drive the antenna about two rotational axes such as azimuth and eleva-

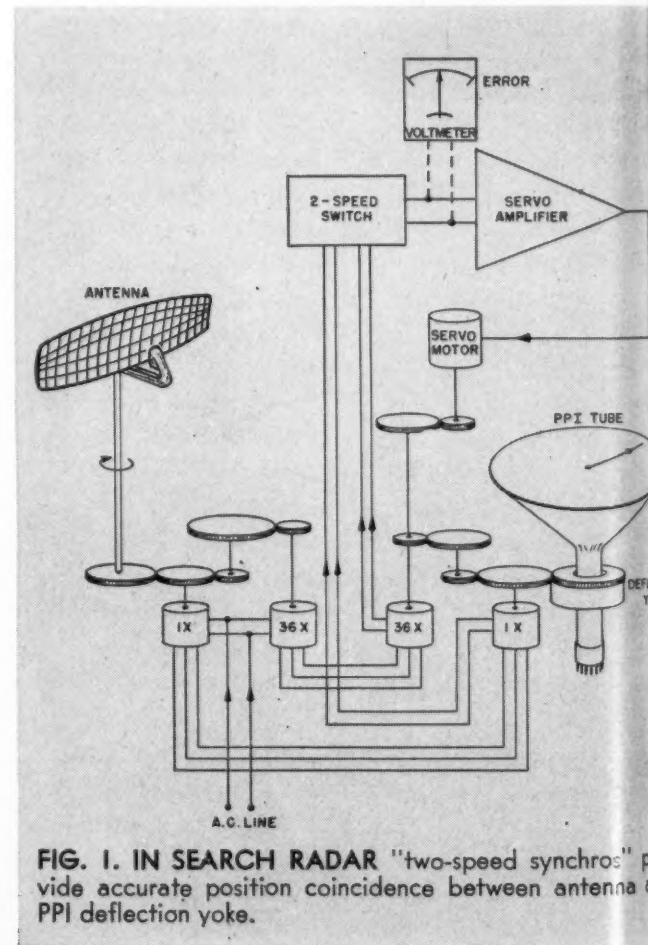


FIG. 1. IN SEARCH RADAR "two-speed synchro" provide accurate position coincidence between antenna and PPI deflection yoke.

tion, to follow and point accurately at the target. As shown in Fig. 2, these servos operate as follows: Radar energy, transmitted by the conical scanning antenna, and reflected by the target, returns with amplitude modulation proportional (within limits) to the displacement of the target from the axis of scanning. The phase of the modulation, referred to the antenna scan cycle, corresponds to the angular position of the target about the scan axis. Thus the modulation may be said to carry, in polar coordinates, the steering information necessary to reposition the antenna onto the target. The scanning reference generator and steering signal demodulators shown in Fig. 2 produce from the radar video, d-c signals corresponding to elevation error and azimuth error respectively. These signals are applied through servo amplifiers to correct the position of the antenna, reducing the error signals to zero.

Tracking radar servos are required to follow any maneuver that a target may perform and are commonly designed to operate with as high a degree of performance accuracy as possible. It is critically important that the dynamic characteristics of these servos be designed and maintained for peak performance.

Tracking radar servos can be tested by (1) prescribing specific "spot check" tests, such as simulating the sudden motion of a target through a small

angle, or giving a sudden constant velocity to a previously stationary target, or (2) performing a dynamic analysis by the frequency response method.

Frequency Response Tests

A complete analysis of the dynamic performance or "transfer function" of a servo may be obtained by measuring the phase and amplitude of the response of the servo to a sinusoidal input signal over a range of frequencies.¹ From the phase and amplitude response curves, performance for any type of signal input can be predicted; further corrective networks can be computed for improvement of deficient portions of the performance characteristic of the servo.²

Either open-loop or closed-loop methods of test may be employed, as shown in Fig. 3. The data obtained from open-loop tests are often more desirable from the designer's point of view, but are sometimes more difficult to obtain. An open-loop servo may have infinite gain at zero frequency, which means that the slightest zero drift tendency in the servo amplifier will cause the servo to drift outside of convenient testing range or against its mechanical stops. Fortunately charts are available which make it possible to read the open-loop performance directly from a plot of closed-loop test data.³

¹ Ref. a, b, d, e, f, g, k, and j

² Ref. a, b, c, d and i

³ Ref. a, c, d and k

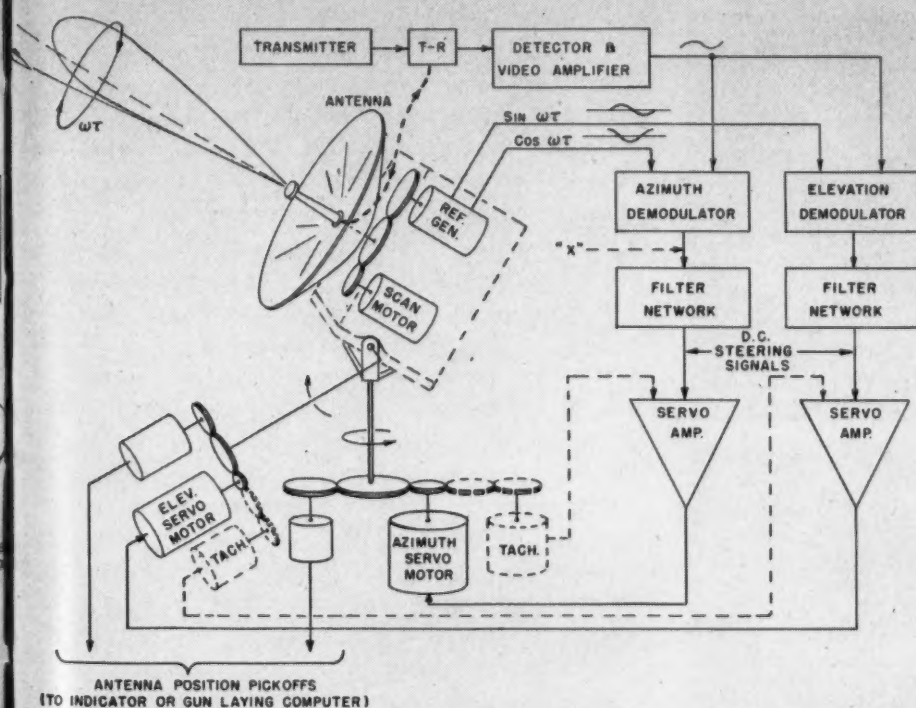
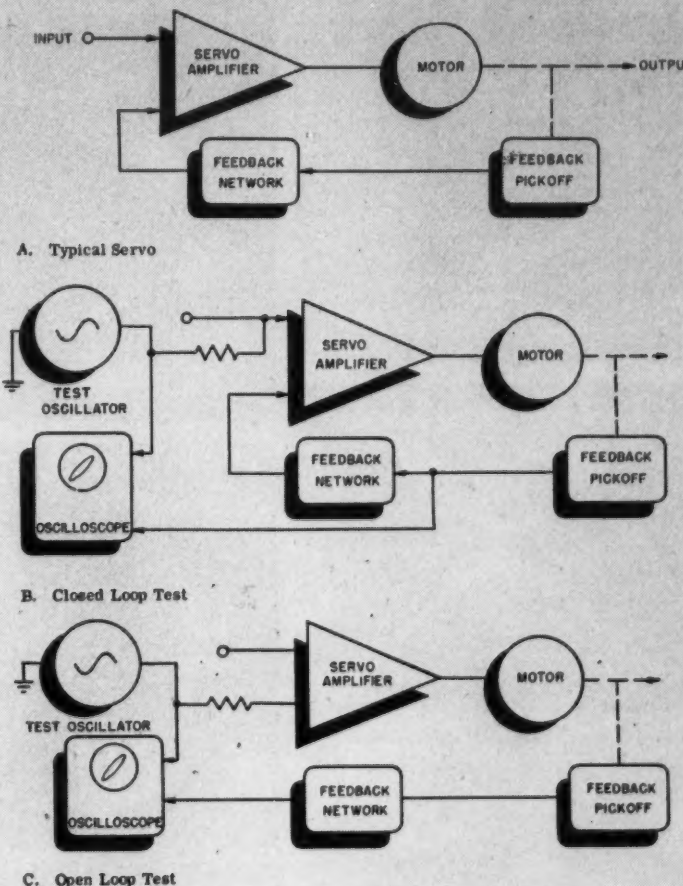


FIG. 2. TRACKING RADAR servos must follow any target maneuver closely—their dynamic characteristics must be maintained at peak performance.

FIG. 3. A CLOSED-LOOP servo system may be tested either under closed or open-loop conditions, with test equipment applied as shown. Dotted lines show mechanical connections; solid lines show electrical connections.



Target Simulation by Mechanical Means

The obvious way to test the angular tracking accuracy of a tracking radar is to move a target in a prescribed pattern, such as sinusoidal. Moving a real target in such a manner is usually impossible, hence a simulated (echo box) target has sometimes been employed for this purpose but even so, cumbersome mechanisms may be required. A variation of this technique is to mount the radar head on gimbals which can be oscillated at the required frequencies. One missile laboratory mounts an entire missile on such an oscillating table and employs a stationary, simulated target.

Target Simulation by Signal

Fortunately, this kind of test can be performed more easily by injecting an electrical signal into the system instead of a mechanical one. For example, injecting a small sinusoidal voltage at point X in Fig. 2 is exactly equivalent to a small sinusoidal target motion, and introduces no errors of any significance within the usable frequency range of the servo. In performing such a test, either a stationary real target or an echo box target may be employed to "complete the loop," since the radar transmission-reception circuitry is a part of the loop.

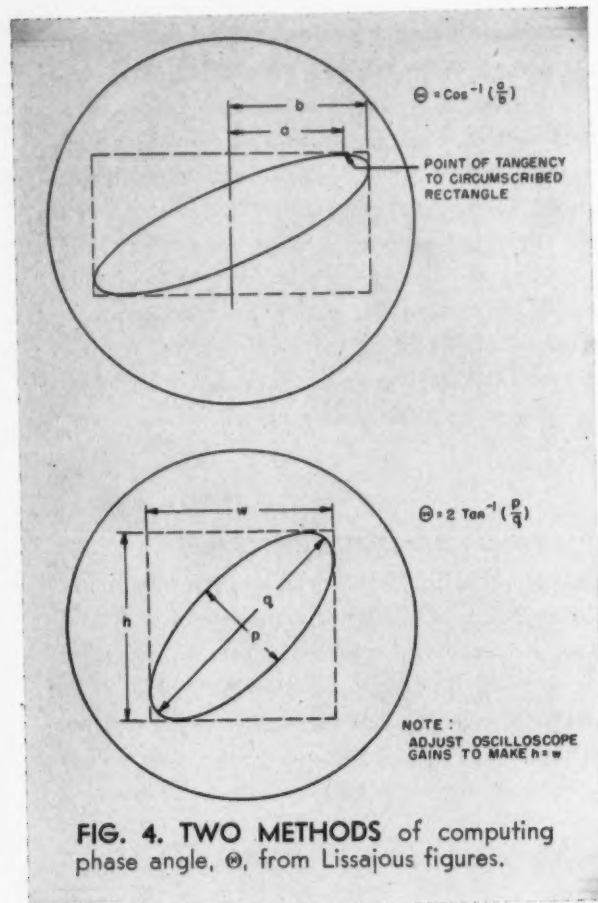


FIG. 4. TWO METHODS of computing phase angle, Θ , from Lissajous figures.

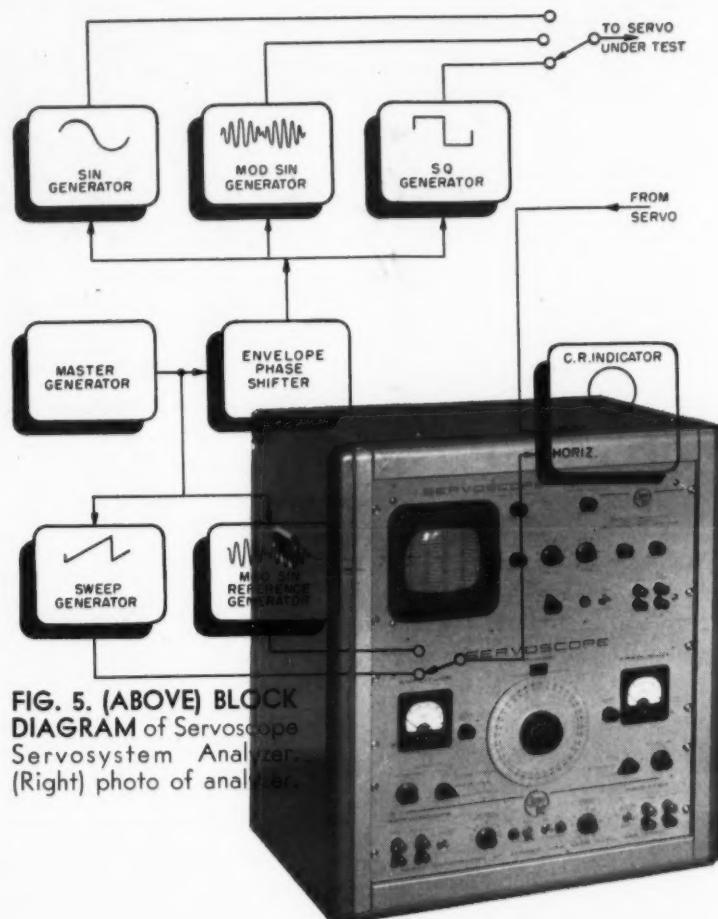


FIG. 5. (ABOVE) BLOCK DIAGRAM of Servoscope Servosystem Analyzer. (Right) photo of analyzer.

Measuring Transfer Function

Test equipment for servo loops provide four functions:

1. *A driving signal of the required amplitude and frequency range.* Frequencies of 0.1 to 20 cps are most commonly required, though as low as 0.001 cps or as high as 100 cps are sometimes called for in special types of servos.

2. *Measurement of gain* (or of output, if input level is held constant). In Figs. 3b and 3c, gain is read from an oscilloscope. Recorders or special low frequency voltmeters could also be used.

3. *Measurement of phase shift.* Phase may be read from the oscilloscope as shown in Figs. 3b and 3c. Fig. 4 shows how this is done by measurement of the Lissajous figure and calculation. An improvement over that method is to provide a phaseable second signal at the test frequency from the test oscillator (see "Servoscope" below), using the oscilloscope simply as a null indicator.

4. *Diagnostic display.* The idealized mechanisms and waveforms described in textbooks are rarely found in practice. Test equipment should include an oscilloscope to permit the operator to diagnose conditions of distortion, backlash, parasitic oscillations, etc. which create servo idiosyncrasies and confuse measurements. Some instruments (such as peak-reading voltmeters for measuring gain, phasemeters of the "zero-crossing" type, etc.) read incorrectly in the presence of such ills.

The Servoscope

The Servoscope Dynamic Analyzer with Servoscope Indicator enables the operator to make complete diagnostic tests of a servo with a single instrument (Fig. 5). It generates various waves used for servo testing, and also modulated carrier and sawtooth waves which are accurately phaseable with the main test signal throughout 360° . For example, a sinusoidal test signal is applied at point X in Fig. 2, and the motion of the antenna, as indicated by a pickoff synchro or potentiometer, is displayed on the vertical axis of the indicator. The "reference" signal is displayed on the horizontal axis. Fig. 6a shows the resulting Lissajous pattern on the long-persistence screen when the sine wave reference signal is employed; Fig. 6b shows the null balance pattern obtained when the phase dial of the Servoscope has been rotated to the unknown phase angle. Amplitude response is read from the height of the oscilloscope pattern as a percentage of the initial pattern.

Figs. 7a, b, c, and d show oscilloscope patterns when "modulated carrier" test input signals are employed, as required in all servos where a "carrier" frequency wave is modulated to convey the signal information. This is the case in the examples of Figs. 1 and 2, where synchros are employed in the signal circuits.

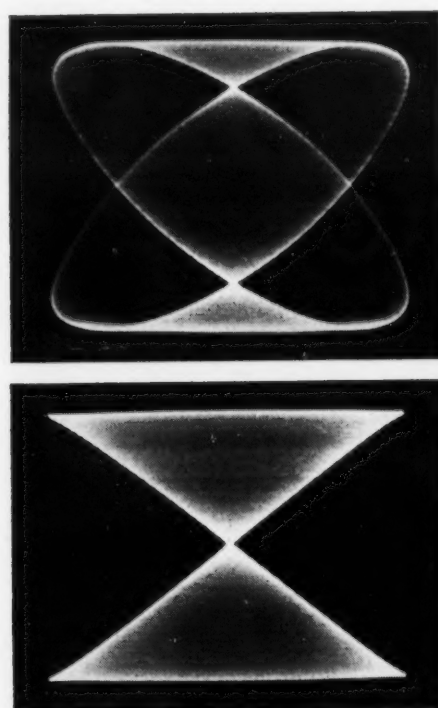


FIG. 6. (a) SERVOSCOPE pattern with sine wave reference signal. (b) Null balance pattern when phase dial of Servoscope has been rotated to the unknown phase angle.

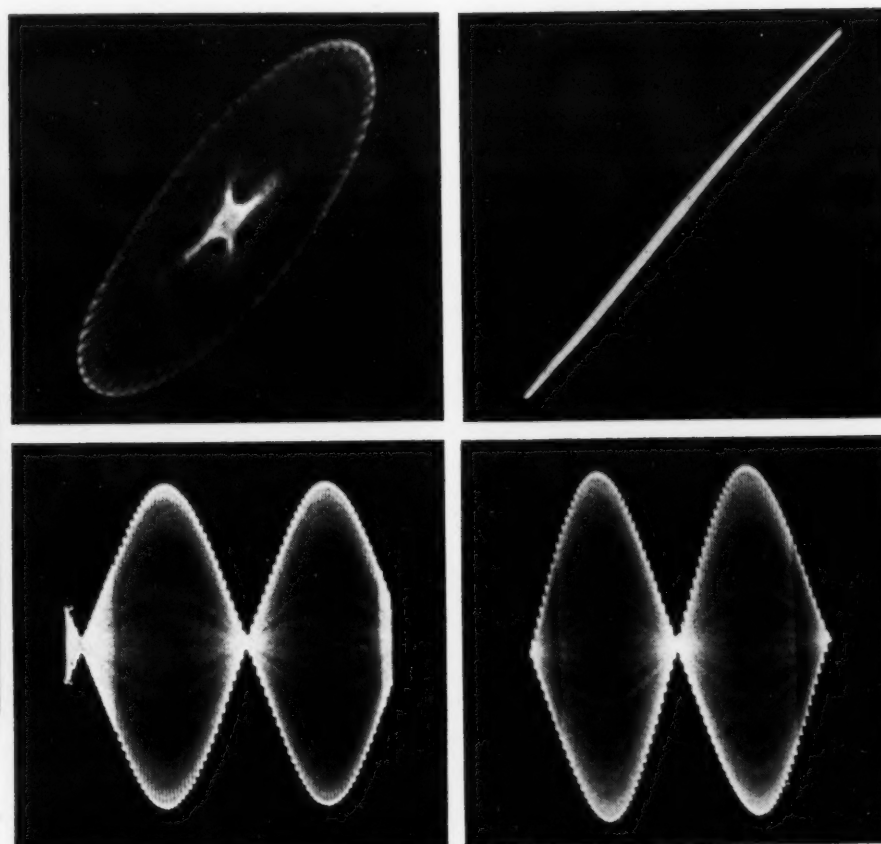


FIG. 7. TYPICAL SERVOSCOPE patterns using "modulated carrier" test input signals.

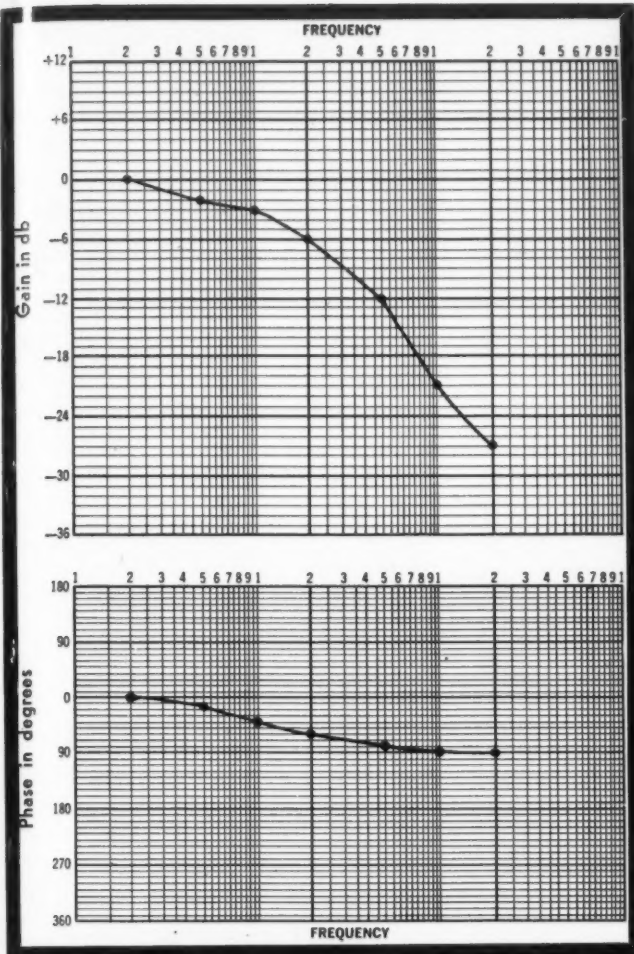


FIG. 8. BODE DIAGRAMS showing gain (in db) and phase plotted against frequency.

Results

The Servoscope permits the complete dynamic test of a radar servo system without extensive mechanical equipment or set-up expense, and obtains the phase and amplitude versus frequency data needed by the servo design engineer for proving or correcting the design of his equipment, or by the maintenance engineer in rechecking the equipment performance to established standards.

Figs. 8 and 9 show plots of actual data taken during a test of a typical servo. Figure 8 is a Bode diagram in two parts showing gain (in decibels) and phase plotted against frequency. The Nyquist chart in Fig. 9 is a polar plot of gain against phase. It is customary to mark each point with its frequency in cps since this cannot be shown any other way. For most servo testing the Nyquist diagram is easiest to use since it involves less mathematical calculation. The Bode plot is particularly useful in forecasting performance of a hypothetical system with data from component specifications rather than from actual system measurements. Test data plotted on either of these charts result in a characteristic curve the shape of which indicates the condition of the servo

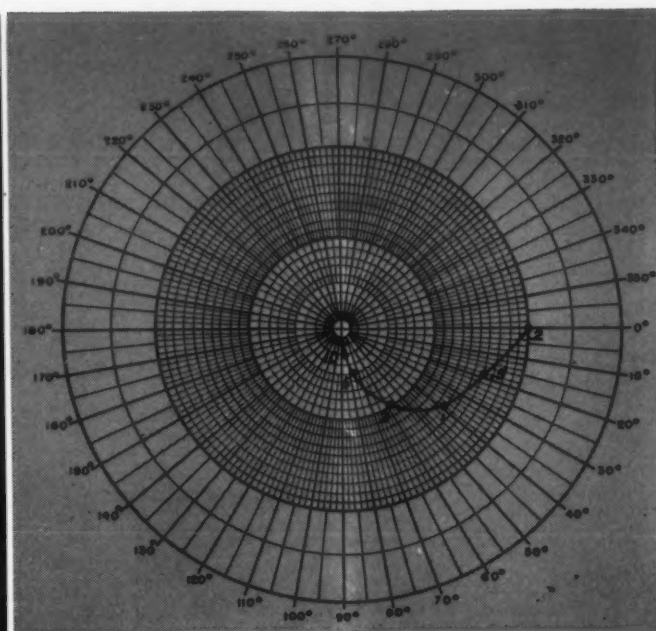


FIG. 9. NYQUIST CHART plots gain against phase. Each point is marked with its frequency in cps.

under test. The tests plotted in Figs. 8 and 9 were made with a Servoscope on a typical servo. The operator had only an hour's instruction in the use of the equipment and completed the test in thirteen minutes. This included connecting the Servoscope to the servo and freehand plotting of the complete Bode and Nyquist diagrams. Such performance is not unusual but can readily be duplicated in either the laboratory or the field.

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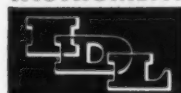
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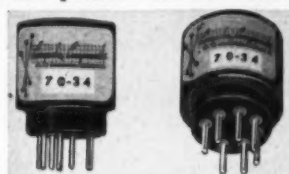
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For more information circle 102 on inquiry card.

MINI PULSE TRANSFORMERS

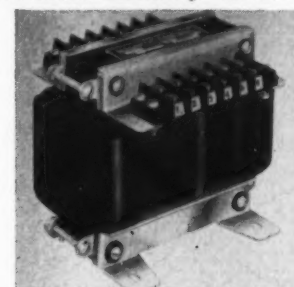
New miniature pulse transformers, custom produced to specifications of individual manufacturers, and supplied with pluggable bases, terminals or leads, will satisfy Mil-T-27A specs. Used in switching circuits to develop pulses, store information, or to couple pulse amplifier stages, they find wide application in computers, blocking oscillators, telemetering, radar, control equipment, etc.—*Erie Resistor Corp., 644 W. 12 St., Erie 6, Pa.*

For more information circle 103 on inquiry card.

JOB-RATED REACTORS

New line of "job-rated" control reactors for magnetic amplifiers com-

prises standard units from 15 to 450 watts in four series covering sensitivity ranges from 1.5 to 3 ampereturns. Military Series meets



Mil-T-27-81 Specs, withstands 2000 G shock tests.—*Chicago Magnetic Control, 1616 N. Damen Ave., Chicago 47, Ill.*

For more information circle 104 on inquiry card.

GYRO TABLE

New gyro transducer combines three free gyros mounted to sense motion about roll, yaw and pitch axes, with caging mechanisms, inverter and radio-noise filters in a 19 1/4 lb

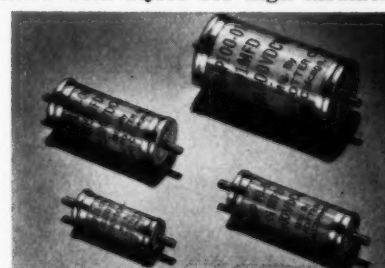


package. Gyros may be driven from a 115 v 400 cps external source or the unit can be supplied with 27 v dc and the 400 cps power generated internally. The unit is hermetically sealed for operation at any altitude and in ambients from -65° to 160° F.—*Clary Dynamics, 408 Junipero St., San Gabriel, Calif.*

For more information circle 105 on inquiry card.

HI-VOLTAGE PLASTIC-DIELECTRIC CAPACITORS

Latest Potter plastic-film high-voltage capacitors, designated Type GMP, have sealed glass-tube cases with metal-ferrule ends, and are impregnated with 1Q160 for high insulation

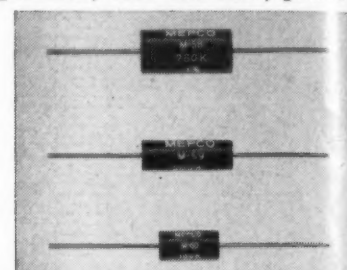


resistance and low power factor over a -60° to 125°C range. Typical capacities ranges available are: At 600 v dc, 0.01 to 0.5 µf; up to 0.0005 to 0.005 µf at 20,000 v dc. Also Type XMP in hermetically sealed cans to 9 µf at 10,000 v dc.—*The Potter Co., 1950 Sheridan Rd., No. Chicago, Ill.*

For more information circle 106 on inquiry card.

MINIATURE WIREWOUND RESISTORS

Miniature encapsulated precision wirewound resistors in MIL styles 9444 AFRT 10, 11, and 12. Designated types M58, M59 and M60, power ca-

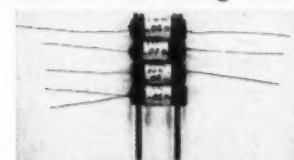


pacities range from 1/4 to 1/2 watt, with a temperature coefficient of 0.003%/°C over the operating range of -65° to 145° C. They are also available in types MR58, MR59 and MR60, meeting Mepco's high reliability specification ME4, which virtually eliminates catastrophic field failures.—*Mepco, Inc., Morristown, N. J.*

For more information circle 107 on inquiry card.

STACKED WIRE-WOUNDS

New 300 series "Multi-stack" encapsulated precision wire wound resistors have radial holes through body ends for mounting and stack-

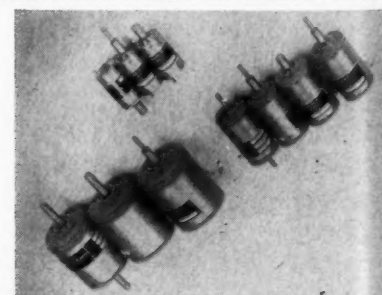


ing. Mounting screws are insulated from terminals, space is conserved, and temperature differences between resistors are equalized. Available in hundreds of types and sizes from 1/4" dia up.—*Consolidated Resistance Co. of America, Inc., 44 Prospect St., Yonkers, N. Y.*

For more information circle 108 on inquiry card.

MAGNETIC CLUTCH-BRAKE COMBOS

Miniature magnetic brakes, clutches and clutch-brakes in BuOrd sizes 8,



11 and 18, in a complete range of operating voltages are available. 24-28 v dc is standard. Environmental requirements certified to meet Mil-E-5272A.—*FAE Instrument Corp., 42-61 Hunter St., Long Island City 1, N. Y.*

For more information circle 109 on inquiry card.

MILITARY AUTOMATION

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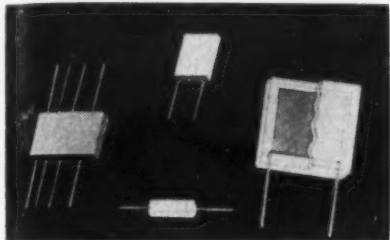
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SMALLER BOBBINLESS WIRE RESISTORS EXCEED MIL-SPEC

New modular, encapsulated, precision wire resistors have completed laboratory tests showing lower temperature coefficients, considerably

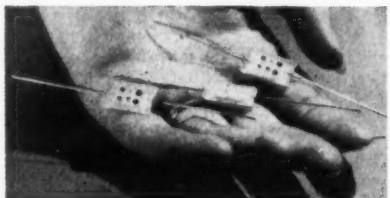


better short-time overload, moisture resistance, high temperature load life, salt-water and temperature cycling, low temperature and operation, acceleration, shock and vibration than required by Mil-R-93B. Tolerance is down to $\pm 0.05\%$ with low inductance and capacitance characteristics.—Chicago Telephone Supply Corp., Elkhart, Ind.

For more information circle 110 on inquiry card.

MINI GLASS CAPACITORS

Miniature fixed glass capacitors, designated type CY, having a continuous operating range from -55° to 125° C, are now suitable for guided

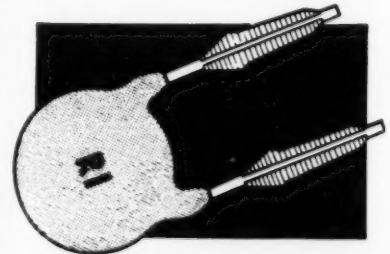


missiles systems, hypersonic aircraft communications and other high temperature uses. CY volumes for 300 v and 500 v dc ratings range from 0.005 cu in to 0.080 cu in; however, capacitors with one-tenth this volume are available for applications where miniaturization is most vital.—Corning Glass Works, Corning, N. Y.

For more information circle 111 on inquiry card.

CAPACITOR LEADS LOCK IN

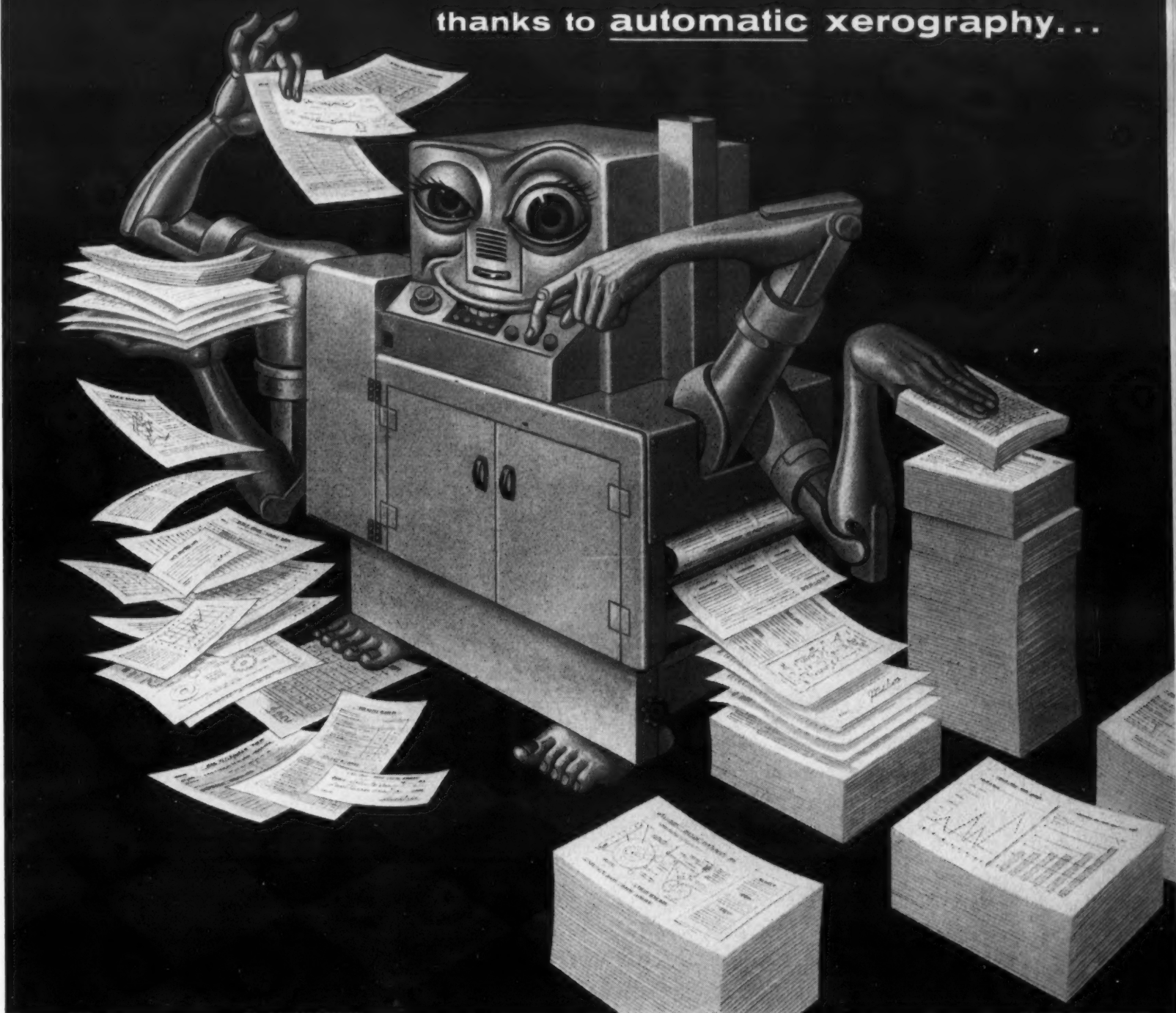
New "Swedge Lead" available on RI-Cap printed circuit capacitors, is



designed to lock firmly into printed circuit boards, facilitate insertion and to prevent dures "pants" from interfering with soldering.—Radio Industries, Inc., 5225 N. Ravenswood Ave., Chicago 40, Ill.

For more information circle 112 on inquiry card.

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Here, as caricatured by Artzybasheff, is the mighty Copyflo® continuous printer—automatic, push-button xerography at its brilliant best—whose enormous appetite for volume copy problems is matched only by its speed, versatility, and high quality of output.

Wherever low-cost, volume copying is the need, look to automatic xerography for the happy solution. Copyflo printers turn out dry, positive

prints up to 11 or 24 inches wide (depending on model), ready for immediate use. Copies emerge at the rate of 20 feet a minute, an $8\frac{1}{2} \times 11$ " print in less than three seconds.

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For more information circle 10 on inquiry card.

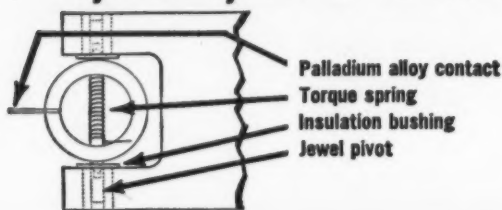
For further information write to: Dept. 58-206X, Haloid Xerox Inc., Rochester 3, N. Y. Branch offices in principal U.S. and Canadian cities.

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May-June, 1958

109

5,000,000 CYCLE LIFE!



II

another result of **dynamic** balance"* precision potentiometers

Long life is achieved by minimizing wear. Wear results from pressures or forces between contact assembly and winding. Total force consists of a dynamic force due to vibration, acceleration and shock; an inertial force acting on the contact assembly; and a static force resulting from contact pressure. For proper operation, contact force must exceed the vector sum of the dynamic forces $F_c > F_v + F_i$.

The Kintronic contact assembly is *dynamically balanced* about a pivot and therefore vibration, acceleration and shock forces cancel out. Inertial force on the contact assembly is minimized by making its mass and size small as possible. Reduction of these dynamic forces enable use of very low contact pressure.

Operational Results: total wear producing force is extremely small. 5,000,000 cycle life is achieved at maximum speeds of 3,425 r.p.m., under 2,000 cycle 30g vibration!

Get complete engineering data on Kintronic "Dynamic Balance" precision potentiometers. Write today.

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For more information circle 11 on inquiry card.

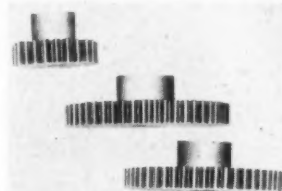
Incidentally, we know these are hot pots mechanically ... but they're also hot for temperature, too. Power derates to zero at 165°C standard — 225°C special.

* Patent Pending

New Products—Cont.

MINIATURE PRECISION GEARS

$\frac{1}{8}$ " face-width precision gears to Class II tolerances are available from

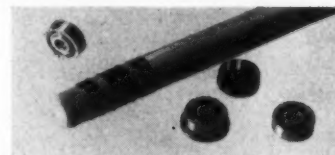


stock in stainless or aluminum in 72, 96 and 120 dia pitch. $\frac{1}{32}$ " face widths available on order.—*Dynamic Gear*, 20 Merrick Rd., Amityville, N. Y.

For more information circle 113 on inquiry card.

MINIATURE BALL BEARINGS

New line of miniature ball bearings, made entirely of vacuum-melt 440-C stainless steel, has retainer



specially designed for each size bearing, made to ARGC-5 tolerances or better. Seven basic sizes and four design variations cover range from $\frac{3}{8}$ " to $\frac{1}{8}$ " O. D.—*The Fafnir Bearing Corp.*, New Britain, Conn.

For more information circle 114 on inquiry card.

QUICK-COUPLING ON SLO-SPEED MOTOR

New type output shaft is latest addition to maker's slow-speed fraction-

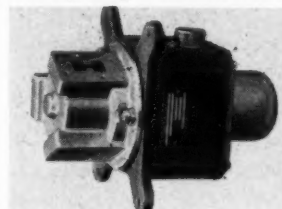


al-horse-power line which includes spur and worm gear types, also types providing variable shaft length, speed and rotation.—*Brevel Products Corp.*, 601 W. 26th St., New York 1, N. Y.

For more information circle 115 on inquiry card.

RIDGED WAVEGUIDE SWITCH

New Model H14A2AA switch has broad frequency characteristics to



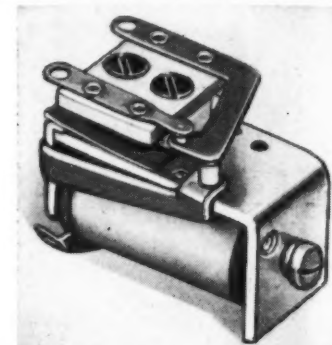
match those of DR19 or SPDT equivalent wave guide. Covers the 4.7 to 11.0 kmc range; Max insertion loss is 0.5 db; crosstalk is 40 db down,

with VSWR under $\frac{1}{15}$ to 1.—*Electronics Div., Thompson Products, Inc.*, 2196 Clarkwood Rd., Cleveland 3, Ohio.

For more information circle 116 on inquiry card.

LOW-C SUB-MIN RELAY

Low capacitance between contact springs mounted on low-loss ceramic

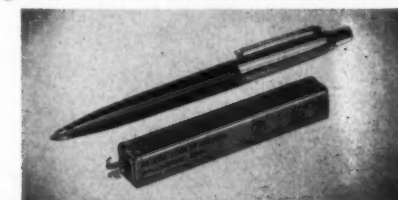


insulation permits use of new relay in antenna change-over applications. Coil voltages 6 to 110 v dc SPST or SPDT contacts are rated 2 amp, 24 v dc or 115 v ac resistive.—*Magnecraft Electric Co.*, 3350 E W. Grand Ave., Chicago 51, Ill.

For more information circle 117 on inquiry card.

SEALED CONTACTS PROVIDE HI-SPEED LONG LIFE

New SPST Glaswitch relay contacts are hermetically sealed in glass, operate in hydrogen-helium atmosphere in 2 to 4 msec to first closure



for over 2 billion cycles at speeds to 400 cps. Contact rating is 0.5 amp dc resistive, 10 watts ac; operating coil range is from 300 to 13,000 ohms.—*Revere Corp. of America*, Wallingford, Conn.

For more information circle 118 on inquiry card.

HI-VOLTAGE VACUUM RELAY

New SPDT RBI relay having 10 kv and 15 amp continuous RF cur-



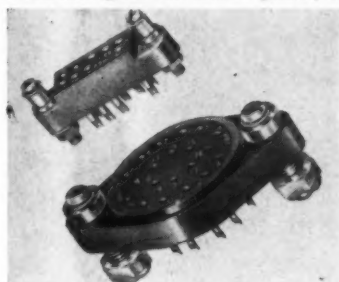
rent rating is designed for radar pulse-forming networks and for aircraft circuits where high voltage insulation is required. Withstands shock and vibration of over 10 G at 500 cps.—*Jennings Radio Mfg. Corp.*, P. O. Box 1278, San Jose, Calif.

For more information circle 119 on inquiry card.

MILITARY AUTOMATION Ma

HERMETIC RELAY SOCKETS

New "Hi-Reli" series of relay sockets for plug-in hermetically sealed relays feature gold on silver plate, free-

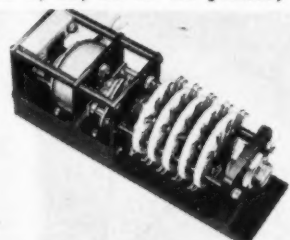


floating screw machine contacts in a molded body of MIL-M-14E specs.—*Arnel Electronics, Inc.*, 840 Fifth Ave., Brooklyn 32, N. Y.

For more information circle 120 on inquiry card.

PROGRAM STEPPER CONTROL

New "Programmer" step switch is supplied in open or sealed models; carries 8, 12, 18 or 24 points; up to

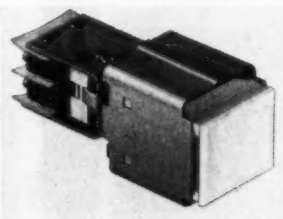


16 wafers with unlimited switching arrangements. Meets and exceeds MIL-S-25259 (proposed), also available for non-military automation applications.—*Guardian Electric Mfg. Co.*, 1621 W. Walnut St., Chicago 12, Ill.

For more information circle 121 on inquiry card.

SPACE SAVING PANEL SWITCH

New "Push-on, push-off" alternate contact DPDT switching unit com-



bines a nameplate and two indicating lights into single modular element. Snap-in translucent button can be removed to replace lamps, change nameplate or button color for operations code.—*Electro-Snap Switch & Mfg. Co.*, 4220 W. Lake St., Chicago 24, Ill.

For more information circle 122 on inquiry card.

WATERPROOF TOGGLE SWITCH

New heavy duty waterproof switch designed for welding applications and other severe environmental conditions has "stay-on, stay-off" feature simi-



lar to toggle switch. Silicone boot over switch bonds to leads to prevent leakage and exclude water, steam or

chemical solutions. Rated at 15 amp resistive at 115 v ac.—*Control Products, Inc.*, 306 Sussex St., Harrison, N. J.

For more information circle 123 on inquiry card.

EXPLOSIVE-ACTUATED DISCONNECT

Reusable Model 2011A explosive electrical disconnect for missile applications incorporates 55-circuit Bendix pigmy connector with threaded



receptacles for two electrical primers, either of which actuates the disconnect thereby enhancing reliability and permitting selective circuit operation if desired. Shear pins hold connector seated until fired.—*Beckman & Whitley, Inc.*, 930 San Carlos Ave., San Carlos, Calif.

For more information circle 124 on inquiry card.

STUB-PLUNGER SNAP-ACTION SWITCH

Life of over 1-million operations is said possible with type 2HBD precision snap-acting miniature switch having special plunger bearing to

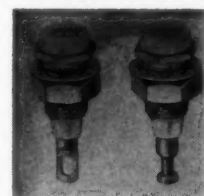


assure smooth action and high repeatability. Rated at 20 amp 125 to 480 v ac; ¼ amp 250 v dc or ½ amp 125 v dc; it is also furnished in horsepower ratings.—*Unimax Switch, The W. L. Maxon Corp.*, Ives Rd., Wallingford, Mass.

For more information circle 125 on inquiry card.

HI-TEMP JACK

New Teflon-insulated test jacks, for -100° to 500°F ambients, fea-

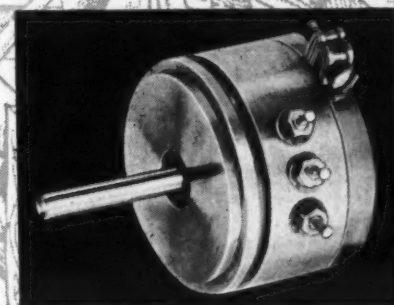


ture beryllium copper spring-pin contacts, silver-plated solder terminals. Meet MIL STD-242A (Ships).—*Raytheon Mfg. Co., Commercial Equip. Div.*, 100 River St., Waltham, Mass.

For more information circle 126 on inquiry card.

RELIABILITY
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THE
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ONLY FAIRCHILD TORTURE-TESTS 1 out of every 100 Production Units

Check These Additional Fairchild Reliability Features:

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- ✓ FAIRCHILD has complete environmental test facilities and does not depend upon outside laboratories for these tests.
- ✓ FAIRCHILD Type tests as well as Quality Control tests are conducted under Air Force surveillance and with approved facilities.
- ✓ FAIRCHILD development units are tested to complete environmental exposure before they are released to the Production Department.
- ✓ FAIRCHILD makes use of pilot production runs to insure performance before full schedule production runs are made.
- ✓ FAIRCHILD has a complete inspection set up including incoming, winding, line and sub assembly inspection and 100% final inspection against customers drawings and specifications.
- ✓ FAIRCHILD Engineering sets up standards for materials and purchased parts in order to meet reliability requirements.
- ✓ FAIRCHILD has three modern air-conditioned plants.

Only Fairchild Linear and Non-Linear Pots incorporate all of the above Reliability features. These High Reliability units can be had in 3/8" to 5" diameters, single and multi-turn, in standard and high temp versions and with accuracies as high as .009%.

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For more information circle 13 on inquiry card.



HI-VOLTAGE RESISTORS

New Type PVX high voltage resistors utilize pyrolytic carbon alloy film with baked-on multiple-layer high-temperature coatings to protect

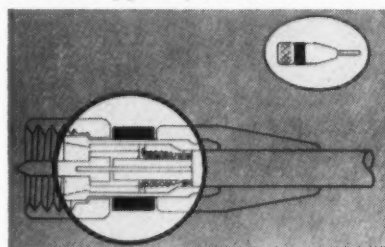


against mechanical damage, moisture, and common transformer oils. Available in 1, 2, and 3 watt sizes.—*International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.*

For more information circle 127 on inquiry card.

CONNECTOR PIN PROTECTOR

Ferrule pin protector of Teflon (illustrated as black ring) prevents accidental pin damage to new Microdot screw-type 50, 70 and 93-ohm mi-



crominiature connectors by holding nut in forward position. Standard in yellow but may be ordered in other colors for circuit coding.—*Microdot, Inc., 220 S. Pasadena Ave., South Pasadena, Calif.*

For more information circle 128 on inquiry card.

MINI-GEARS FIT MARK 7 MOTORS

New Daco precision gear head providing ratios from 15:0 to 4300:1



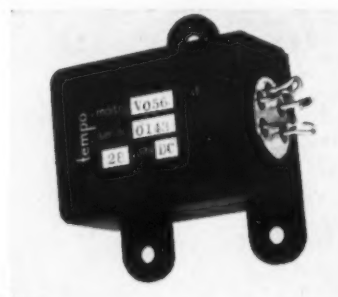
uses adapter ring to mount on standard Mark 7 servo motor. Backlash is held to 30 min with a 5 oz-in reversing load.—*Daco Inst. Co., Tillary & Prince Sts., Brooklyn 1, N. Y.*

For more information circle 129 on inquiry card.

TRANSISTORIZED TIME-DELAY RELAY

New heavy-duty time-delay relays using transistors and RC time-constant elements in lieu of mechanical or thermal elements achieve: Delay periods from 0.01 to 60 sec.; timing accuracy of 10%; operate in ambients from -55 to 125° C; shock-resistance to 50 G for 11 ms; vibration, 10-80

cps, 0.12" peak double amplitude, 80-2000 cps at 20 G; and contact life of 100,000 cycles minimum at 10 amp resistive. In SPDT and 3PDT, 28 v

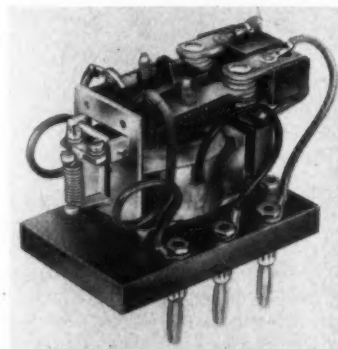


dc input models are standard with special voltage delays and ac inputs available.—*Tempo Inst. Inc., 240 Old Country Rd., Hicksville, N. Y.*

For more information circle 130 on inquiry card.

PLUG-IN RELAY

New general purpose relay, available in a wide range of ac and dc coil

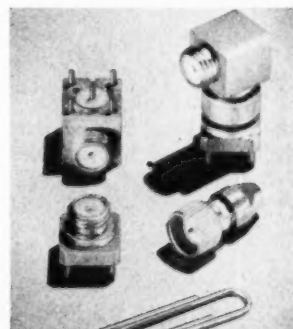


voltages with contact arrangement 2 Form C, rated 20 amps, 115 v ac or 24 v dc, features standard plug or jack terminals for rapid attachment to mating fixture on user's equipment.—*Wheelock Signals, Inc., Long Branch, N. J.*

For more information circle 131 on inquiry card.

MINIATURE COAXIAL CONNECTORS

New WCC series coaxial connectors for mounting on printed circuit

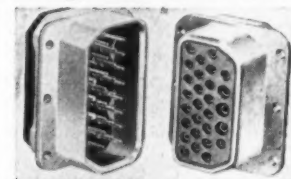


boards are available in 50 and 93-ohm impedances. 50-ohm constant impedance group is illustrated, with 500 dc rating.—*H. H. Buggie, Inc., Box 817, Toledo 1, Ohio.*

For more information circle 132 on inquiry card.

"POKE HOME" CONTACT CONNECTOR

New type contacts allow soldering or crimping of contact externally from connector before circuit assembly. Contacts may be removed from connector at any time for replacement or rerouting. Insert arrangements range from 15 to 63 contacts.

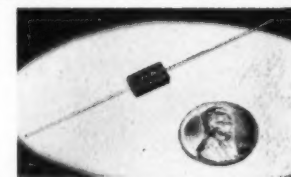


Polarized shells are forged aluminum with diallyl phthalate insert.—*Amphenol Electronics Corp., 1830 S. 54 Ave., Chicago 50, Ill.*

For more information circle 133 on inquiry card.

SUBMIN MICA CAPACITOR

New "Missil-Mite" molded mica capacitor is said to be 73% smaller than next-smallest mica unit. Capacities from 5μf through

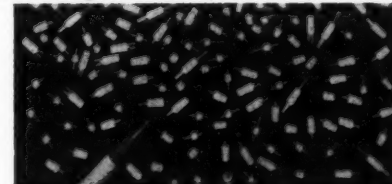


240μf are available with tolerances from ±2% to ±20% at working voltages of 300 v at 85° C and 200 v at 125° C.—*Micamold Electronics Mfg. Div., General Instrument Corp., 1087 Flushing Ave., Brooklyn, N. Y.*

For more information circle 134 on inquiry card.

WIDE VARIETY IN TEFLON TERMINALS

Over 200 types of Teflon terminals including turreted, threaded, slotted



and hollow-lug standoff and feedthru types, are now available in standard and "reversed" constructions, allowing one-side chassis connections to be made.—*Trinseel, Inc., Div. of Tri-Point Plastics, Inc., Albertson, N. Y.*

For more information circle 135 on inquiry card.

CONNECTOR FOR RUGGED ENVIRONMENTS

New "EX" line of connectors resistant to heat, vibration, and sealed for extreme altitudes, use Monobloc Silicone insert arrangements and mate with MS, MS-E, and Cannon Electric hermetically sealed GS connectors. Meet Mil-C-5015 and Mil-E-5272, operate up to 325° F.—*Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.*

For more information circle 136 on inquiry card.

THRU-BULKHEAD CONNECTOR

New Model DM 9603 environmental unit carries connections through bulk-



head to enable positive push-pull connection from either side. Both ends mate with Deutsch Models DM6502 and DM9700.—*The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.*

For more information circle 137 on inquiry card.

INSTRUMENT DRYER IS SELF-REACTIVATING

Static (non-reactivating) airborne instrument dryers can now be replaced with the new Model A-10 dryer which uses a permanent dessicant

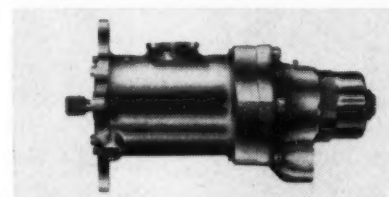


automatically reactivated during changes in altitude. New unit breathes air in and out, to equalize pressure, dehumidify, filter and clean air passing into the instrument. Requires 28 or 115 v ac or dc; 35, 50 or 65 watts for 1/2, 1 and 1 1/2 cu-ft sizes.—*Daco Inst. Co., Tillary & Prince Sts., Brooklyn 1, N. Y.*

For more information circle 138 on inquiry card.

HI-TEMP HYDRAULIC PUMP

New 3 gpm, 450° F stainless steel and special alloy pump is designed

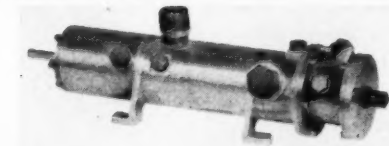


for advanced aircraft and missile applications. Designated Model 69W030, it is said to be capable of operating in ambients to 700° F.—*Watertown Div., New York Air Brake Co., Starbuck Ave., Watertown, N. Y.*

For more information circle 139 on inquiry card.

HYDRAULIC POWER PACKAGE

New dependable source of controlled hydraulic power for servos and other



hydraulic applications consists of pressurized reservoir, Dynacor pump, filter element, relief valve, and piston-type accumulator charged with inert gas. Measures 2 1/2" x 12" long; dry weight, 7 1/2 lbs.—*Applied Dynamics Labs., 32 N. Main St., Natick, Mass.*

For more information circle 140 on inquiry card.

MINIATURE VARIABLE DISPLACEMENT PUMP

New PV-3906 variable displacement pump, adaptable to a broad range of control methods, and minia-

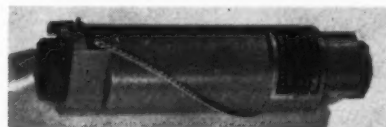


turized to 2.4 lbs, retains high efficiency and response characteristics of normal sized pumps. Maximum continuous speeds are 12,000 rpm for aircraft and 18,000 for missile use.—*Vickers, Inc., Detroit 32, Mich.*

For more information circle 141 on inquiry card.

UNBALANCED RELIEF VALVE

New 52-114 Series in-line hydraulic relief valves meeting MIL-V-5523B operates in temperatures from -65° F to 275° F and at pressures to 400

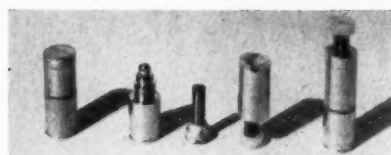


psi. Only static O-ring seals are used, resulting in low differential between cracking pressure and reseal pressure. Available in 1/4", 3/8", 1/2" and 3/4" tube sizes. The flow capacity of the 1/2" valve is comparable to the conventional 3/4" unit with approx half the pressure differential between full flow and re-seat.—*Arkwin Industries, Inc., 648 Main St., Westbury, N. Y.*

For more information circle 142 on inquiry card.

INERTIA SWITCHES

New miniature inertia switches in basic momentary and magnetic-hold (reset) types use a simple principle requiring one moving part. When iron cap is used, steel ball is held in closed circuit position until plastic



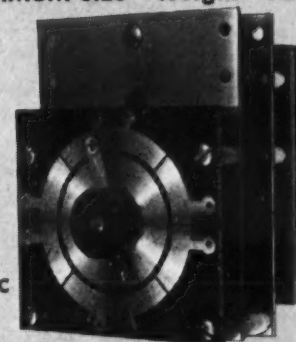
reset button is pushed. In momentary contact switch, brass cap permits ball to return to open position every time the acceleration falls below the closure level. Switches are available in 24 standard models providing acceleration levels from 0.15 to 20G.—*Inertia Switch Div., Safe Lighting, Inc., 527 Lexington Ave., New York 17, N. Y.*

For more information circle 143 on inquiry card.

HIGH ALTITUDE BALLOON

CONTROL INSTRUMENTS
require MAXIMUM Performance
MINIMUM Size - Weight - Power Drain

Brailsford
AGC Timers
Are Unmatched
In These Basic
Requirements



Model AGC

If You Have A
Timing Problem
Where Size,
Mass and Power
Drain Are Critical
Read These

SPECIFICATIONS

Number of decks—1-4 • Speed regulation—±1.0% at 50% voltage shift
Size—1 3/4" x 2 1/4"—depth depends on number of decks
Segments per deck—2-8 for stock units.
Special commutators to order for a nominal tool charge.
Shorting or non-shorting contact • Power input—.008 Amp. at 6 VDC

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For more information circle 14 on inquiry card.

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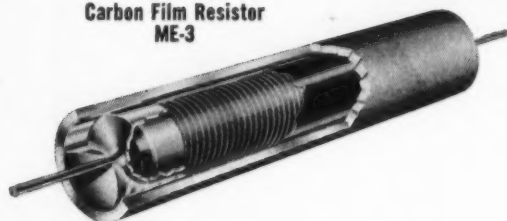
For more information circle 15 on inquiry card.

FACTUAL

RESISTOR

RELIABILITY !!

Carbon Film Resistor
ME-3



Wire Wound Resistor
ME-4



IT IS A KNOWN FACT THAT **RELIABILITY**
CANNOT BE "**TESTED**" INTO A COMPONENT

- **RELIABILITY** must be "Built In" to the best of one's ability and then the component must undergo a series of properly designed tests in order to weed out potential failures.
- Testing procedures must vary, dependent upon the specific type resistor under consideration.
- In the process of manufacturing and testing many millions of both Encapsulated Wire Wound and Hermetically Sealed Deposited Carbon Resistors, MEPCO has developed testing techniques which have definitely reduced catastrophic field failures to a minimum, consistent with the state of the manufacturing art.
- MEPCO high reliability test specifications outline the procedures utilized in this program. ME-3 covers hermetically sealed carbon film types and ME-4 precision wire wound units. Further information on both available upon request.

Arrangements have been made for private discussion of your problems relating to the above at the 2nd National Convention on Military Electronics, June 16th-18th at the Sheraton Park Hotel, Washington, D. C. Write us now for details or see us at Booth #39 during show hours.

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MORRISTOWN
NEW JERSEY

For more information circle 16 on inquiry card.

Chemical Warfare Defense Aided By Infrared

Early detection of highly toxic chemical warfare agents, for over twelve years a major problem in chemical warfare, now may be solved by a new infrared development designated LOPAIR (for long-path infrared). The gas mask in its present improved form is effective against new invisible, odorless and tasteless gasses but must be fitted in place before its wearer has inhaled the vapor. In the past, no device was sufficiently sensitive and selective to provide advance warning to enable troops to don masks in time for complete protection.

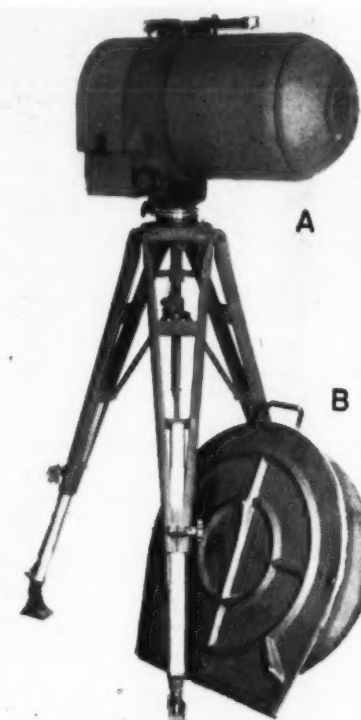


FIG. 1. LONG PATH infrared war gas detector uses absorption principle.

The new detection device will flash a light or sound an alarm when a tiny amount of contaminant is detected as far away as a quarter-mile. Consisting of (A) the detector head, containing an infrared source and an analyzing detector; and (B) a self-aligning mirror, which is placed at the far end of the beam to intercept and return the infrared beam to the analyzer, LOPAIR is said to be capable of detecting a concentration of vapor from a pin-head sized droplet of liquid gas dispersed in an average room.

Once the analyzer has been set to respond to the characteristic infrared spectrum of a vapor, it will not be set off by any other materials likely to be present. It cannot be set off by any object breaking the beam between the two units. Besides its anticipated use by troops in the detection of gasses, LOPAIR can also be used for air pollution studies in factories, mines, etc. LOPAIR was developed by the Farrand Optical Co., Inc., 4401 Bronx Blvd., New York 70, N. Y. for the U. S. Army Chemical Corps. If approved after final tests, it will be available to all branches of the Armed Forces.

For more information on LOPAIR circle 144 on inquiry card.

MILITARY AUTOMATION

Trisonic Data Processing

ACCCELERATION of missile and aircraft research during the coming months will be pressed in many laboratories. Automatic processing of wind tunnel data will be one technique emphasized in order to cut down tunnel "dead time" and to put significant test results into the hands of the design engineers while the model is in place and ready for additional testing. Previous methods of data processing have required hours to days before approximate test results could be determined.

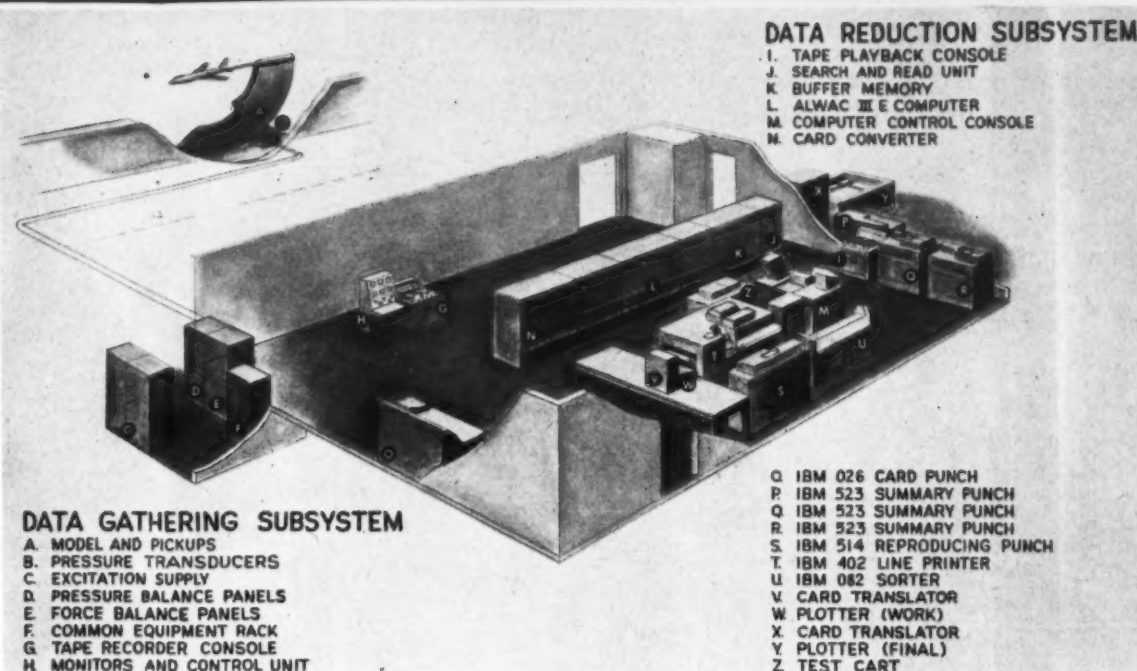
One of the latest data processing systems has been developed by the Autonetics Division of North American Aviation for their new Trisonic Wind Tunnel at Los Angeles, Calif. This new test facility, capable of making subsonic, transonic and supersonic tests at air speeds up to 2,500 mph, is of the intermittent blow type. The system is designed so that data taken during a test blow can be processed and presented in graphic form between runs. This important feature will allow tunnel operators to modify or sometimes eliminate the next-planned test run in accordance with results of the test just completed. Hours to days can be saved in a single set of tests, with the result that design engineers can make better headway with any single project and the total number of projects the test facility can accommodate will be greatly increased. The new \$5-million wind tunnel will first be used in further tests of North American's advanced WS-110 strategic bomber design program.

The data handling system (Fig. 1) comprises two subsystems: 1) a data gathering subsystem capable of collecting information from 144 sensing elements at the rate of 3600 points each second, and 2) a data reduction subsystem which can accept this information, make the desired computations and present completed charts in 15 to 30 minutes.

Data Gathering

Basically, the data gathering subsystem (Fig. 2) collects analog information from three or more types of transducers, converts this information into digital form and then records it for later processing. The transducers include strain gages to measure forces, pressure transducers to measure pressures and a po-

FIG. 1. DATA handling system comprises (1) data gathering and (2) data reduction subsystems.



tentiometer to measure angle-of-attack of the model under test. Each force-measuring channel can be separately calibrated (Fig. 3).

At a patch panel, the data gathering operator can select the transducers needed and their arrangement. A sampling switch, sweeping the transducer outputs in turn, delivers each signal to the Epsco Model B Datrac, an analog-to-digital converter which converts it into 11-bit binary code form in less than 150 μ sec. These outputs are recorded on magnetic tape for more leisurely processing and analysis in accordance with the requirements of the specific test being run.

Six meters with associated relays monitor all forces on the model and give audible and visual warnings when any of six selected forces exceed pre-determined levels.

Data Reduction

The data reduction subsystem's (Fig. 4) function is simply to edit the digital data received from the data gathering subsystem, process the selected data and present it in the desired output form.

The input data to this subsystem is derived from the playback of the magnetic tapes. Instructions and miscellaneous information are fed into a computer by means of a typewriter and punched cards.

The search and read unit selects predetermined blocks of information from the tape and feeds these through a buffer memory into the computer. The com-

puter then performs the required mathematical and logical operations and provides the output information in punched-card form.

Output punched cards are sorted into groups. One group operates a Mosely Model 2 Autograf point plotter which prepares work plots of the test results. The other group of cards is used to prepare a printed table of test results. After a number of such runs have been made, cards representing selected portions of various tests are used to prepare final plots on a Benson-Lehner Model G Electroplotter.

On-Line Operation

If desired, output data from the data gathering unit may be fed directly into the data processing computer in what is termed an "on-line" operation. In this mode of operation, a limited range of measured results will be available to the engineers immediately upon termination of the test blow. Preliminary tests so made can quickly determine whether model modifications are "in the ball park", while all data gathered are simultaneously recorded for later complete processing.

North American's Trisonic Wind Tunnel, one of the industry's most spectacular laboratory tools, is versatile in its adaptability to advancing testing requirements. It is the largest of its type privately owned in the United States.

For more information circle 145 on inquiry card.

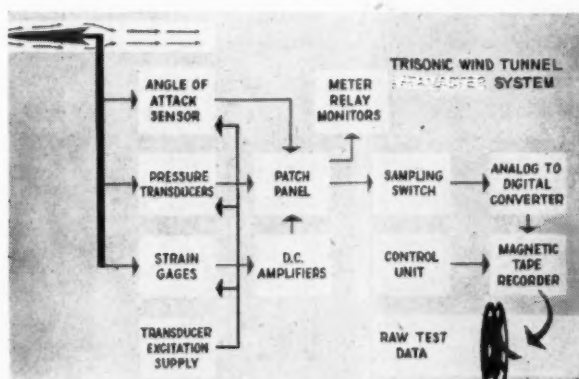


FIG. 2. DATA gathering system flow diagram.

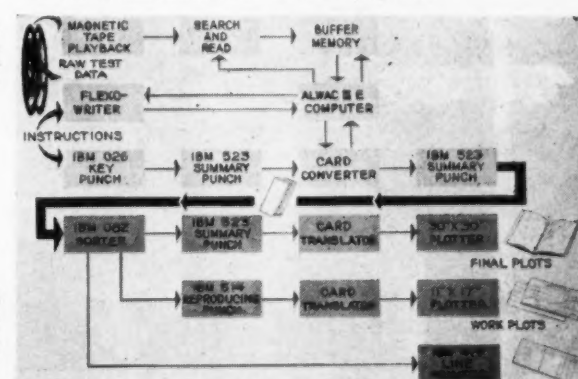


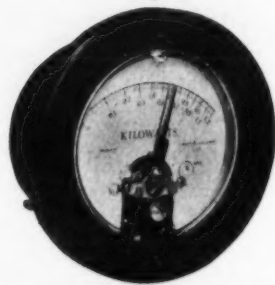
FIG. 3. DATA reduction system flow diagram.

MILITARY
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MODEL 355-C METER-RELAY

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RUGGED?



UP TO 20,000,000 OPERATIONS!!!

Assembly Products Inc.

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Chesterland 76, Ohio

For more information circle 17 on inquiry card.

Rugged 355-C control relay meets or exceeds the following:

Shock test: Total of 18 impact shocks of 15 G's.

Water tightness: submerged in tap water at a pressure of 2½" mercury for 5 minutes.

Dielectric strength: 1000 volts RMS at insulated parts.

Vibration: Survives 10-55-10 cps, .060 amplitude, 1 minute cycle, 1 hour, 3 axes.

Corrosion: Passes 50 hour salt spray (QQ-M-151a).

Contacts: Rated 100 Ma, insulation to signal coil rated 300 volts DC.

Description: Has a set of contacts in series with locking coil. Signal and locking coil, both on moving structure, lock pointer contacts positively. Resets when contact circuit is interrupted.

Magnetically-Damped Pickup Measures "Jerk"



FIG. 1. NEW VIBRATION pickup has characteristic adapted for measurement of jerk.

Measurements of low-frequency "jerk," (the third derivative of displacement with respect to time) are now possible, using the same pickup which is used to measure higher frequency vibrations. The success of the new magnetically-damped Type 128-1 MB Vibration Pickup (Fig. 1) in the testing of a recently-accepted air-to-surface missile has opened up new possibilities in the design-for-comfort of such rough-riding means of locomotion as tanks, trucks, earth-moving equipment and sulky farm tools; fields far removed from the initial use of the pickup in missile testing.

"Jerk," which produces major discomfort to vehicle passengers, and possibly lethal effects to passengers of a missile making re-entry into an atmosphere, is a low frequency displacement in which the rate of acceleration is changing. The construction of the Type 128-1 pickup (Fig. 2) features a light moving coil which is restricted to a single degree-of-freedom movement in a strong magnetic field. This field provides magnetic damping for low frequency responses as well as excitation for the coil output.

The response curve of the pickup (Fig. 3) shows that its output is constant to nearly 8 cps. The voltage of any output with a frequency lower than this can therefore be interpreted as proportional to "jerk." If

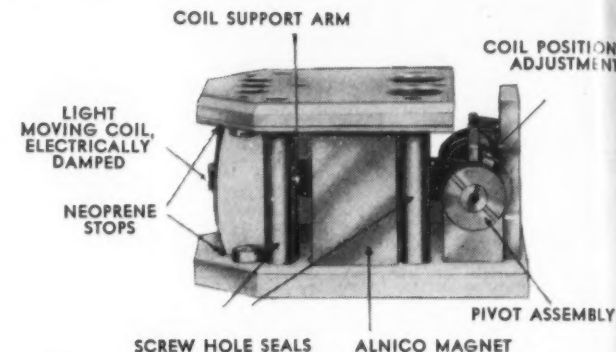
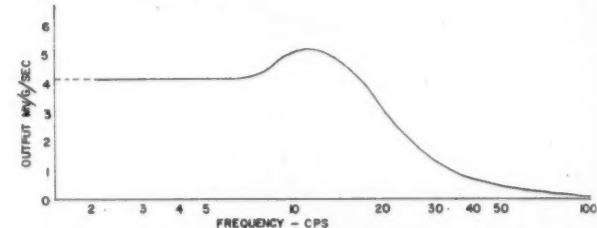


FIG. 2. CONSTRUCTION of MB Type 128 pickup.

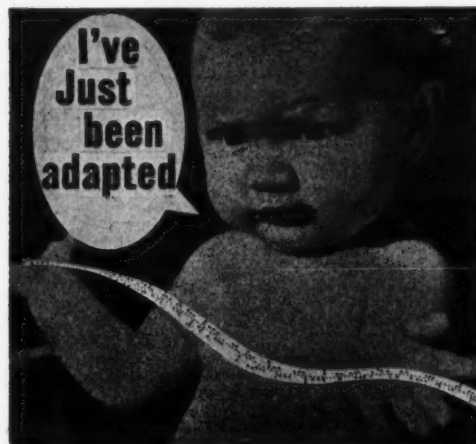
FIG. 3. FREQUENCY-OUTPUT response curve, Type 128 pickup.



present, higher frequency oscillations can be eliminated from this measurement by means of a suitable low-pass filter.

Measurement of high frequency vibrations superimposed on a steady-state accelerations of up to $\pm 5G$ can also be accomplished with little change in sensitivity over an ambient temperature range of -65° to $250^\circ F$. Because of the relatively stiff suspension of the moving coil, the pickup is relatively insensitive to steady-state accelerations under $\pm 5G$. By referring to the response curve, the data taken (an analog voltage varying in amplitude and frequency) can be computed to indicate either acceleration displacement or velocity. The Type 128-1 Vibration Pickup is a development of the MB Manufacturing Co., a division of Textron, Inc., New Haven, Conn.

For more information circle 146 on inquiry card.



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line of
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"Miracle
Presto-
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ANOTHER FIRST!

Splicing Digital Paper Tape or Bizmac Tape without cement or adhesives.

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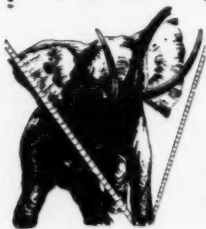
- Models available for all size digital tapes.
- If it's a splicer you need which does not use cement or adhesives, we make it.
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For more information circle 18 on inquiry card.



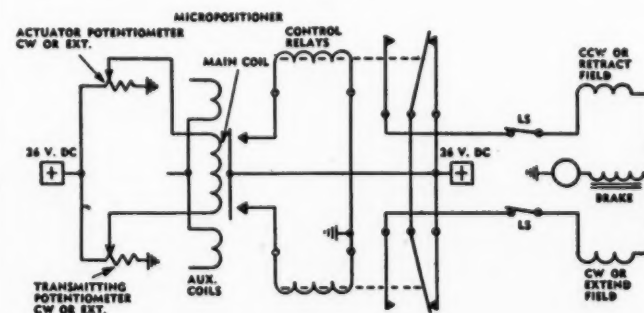
High Speed Servo System

Remote control of aircraft throttles, jet afterburner valves, test cell apparatus and other applications requiring rapid, accurate response is accomplished by a new 26 v dc velocity-feedback servo system. It consists of either a rotary or linear actuator with integral potentiometer, a transmitting potentiometer, and

a control box housing other circuit components. The two potentiometers are connected to form a basic Wheatstone bridge in which the Micropositioner, an ultra-sensitive polarized relay, is used as the bridge balance detector.

Rapid, accurate response at high velocities is obtained without hunting at speeds up to $90^\circ/sec$ (15 rpm) or $1"/sec$ (linear). Anti-hunting is accomplished by a unique velocity feedback circuit utilizing the principle that the generated "back emf" of a dc motor is proportional to its speed. Independent calibrating rheostats adjust the amount of anticipation for each direction of travel, matching a wide range of inertia at the load. Underdamped, overdamped, and critically damped conditions can be readily obtained. (From 60-page technical catalog, Aircraft Controls, Barber-Colman Co., Rockford, Ill.)

For this literature circle 147 on inquiry card.



1 MEGACYCLE AUTOMATIC CAPACITANCE LIMIT BRIDGE



BUILT-IN STANDARDS

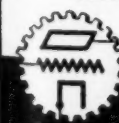
MODEL AB-5 AUTO-BRIDGE

First time available anywhere... high speed, 1 MC automatic capacitance limit bridge to meet all government and commercial testing specifications. Complete in itself with built-in precision standards... no external capacitors required. Perfect for lab or production testing applications. Truly high-speed testing... no knobs or dials to turn... no meters to read. When used as a simple indicator, green light indicates test capacitor within tolerance, red and amber lights indicate high or low out of tolerance unit. This can also be supplied with semi or fully automatic component feeding and sorting mechanisms.

SPECIFICATIONS

- FREQUENCY—1 megacycle
- RANGE OF MEASUREMENT — 0-1000 mmf (+ tolerance adjustable to 100%, — tolerance to 25%).
- ACCURACY — Guaranteed accuracy ½% from 0 to 500 mmf, 1% up to 1000 mmf.
- SPEED OF RESPONSE — Less than 1/10 second.

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89 Commerce Road, Cedar Grove, Essex County, N. J.

Dynamic Balancing of Masses Important in Potentiometers

Importance of mechanical as well as electrical precision is featured in the design of the new Kintronic 1000 Series potentiometers, dynamically balanced for severe environmental applications. The concept of dynamic balance centers around the contact. The palladium contact in its assembly is mounted and dynamically balanced in jewelled pivots at the end of a husky arm, which in turn is securely clamped on the shaft and also dynamically balanced on the shaft (see illustrations). Because dynamic balance is main-

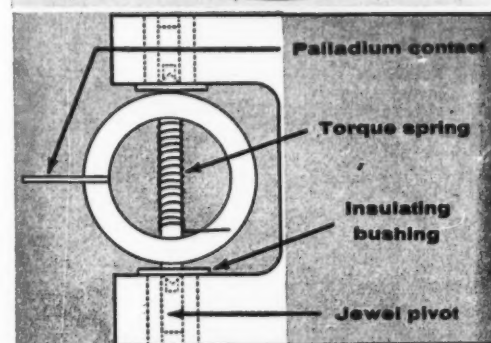
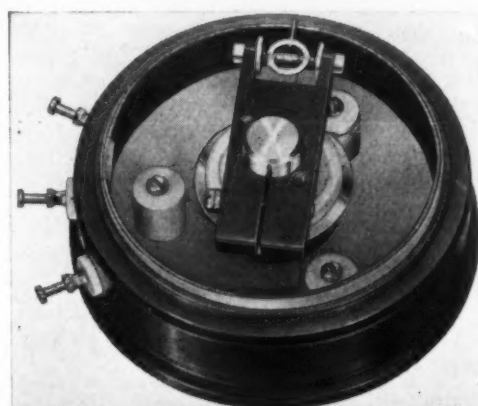


FIG. 1. EXCEPTIONAL environmental performance is said to result from dynamic balancing principle.

tained in all parts, only light torque-spring pressure assures constant contact with the winding under the most severe environmental conditions. Maximum rotational speed, life expectancy and long term accuracy are all improved.

That attention to mechanical precision and balance "pays off" is evident from a reading of the performance specifications of the new series: Life, 5 million cycles; vibration 30G at 2,000 cps; rotational speeds from 1,000 to 3,425 rpm depending on size; and starting torques as low as 0.1 oz-in for the smallest size. Kintronic pots are available in six standard sizes from 7/8" to 3", with either functional or linear windings available in each size. All-metal housings, silicon-glass laminate winding cards, and only ceramic and teflon parts used in interior construction ensure reliable high temperature operation. The 1000 Series potentiometers are a development of the Kintronic Division of Chicago Aerial Industries, 10265 Franklin Ave., Franklin Park, Ill., represented in the South West by the Paul F. Wiley Co., Los Angeles, Calif.

For more information circle 148 on inquiry card.

muscles for missile servos



KEARFOTT SERVO MOTORS MEET ALL REQUIREMENTS OF RELIABLE, HIGH-PERFORMANCE MISSILE SERVO SYSTEMS.

SHOCK AND VIBRATION: Ruggedized to withstand 30 g's and 2000 cps

TEMPERATURE: Designed for operation at 400° F. or higher.

CORROSION RESISTANT: Materials used assure freedom from corrosion.

IMPEDANCE LEVEL: Matched to function with transistorized amplifiers.

TYPE	SIZE	STALL TORQUE OZ.—IN.	NO LOAD SPEED RPM	VOLTAGE 01/02	TRANSISTORIZED AMPLIFIER
400 cps					
R-123-5	8	.33	6500	26/40V	A3105
R-124-5	10	.28	6500	26/40V	A3105
R-119-5	11	.60	6200	115/40V	A3106
R-110-5	15	1.45	5000	115/40V	A3106
R-111-5	18	2.4	4800	115/40V	A3104
R-112-5	18	2.8	9800	115/40V	A3104
60 cps					
R-160-5	18	3.5	3400	115/40V	A3300

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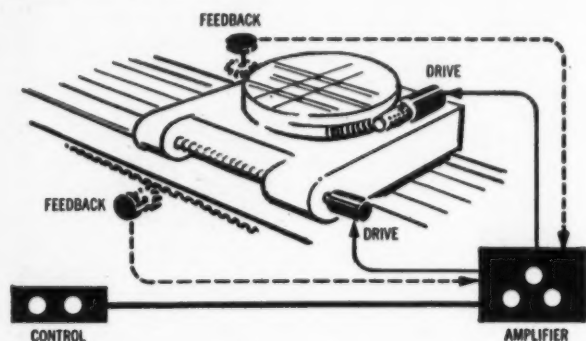
For more information circle 20 on inquiry card.

For more information circle 19 on inquiry card.

May-June, 1958

Servo System Package

Adaptable for controlling valves, feed screws, antennas, throttles tuning, remote TV—for machine tools, chemical and nuclear processes, this unit combines flexibility with simplicity, high performance with economy. A sensing element such as a pressure transducer (or flow, speed, temperature, level, etc.) may be provided in lieu of the manually operated potentiometer. A complete automatic controller, or only the actuator-amplifier elements to receive the error signal, can be furnished.



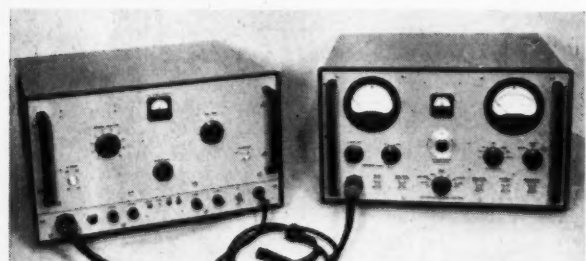
The basic circuit consists of an electronic amplifier across a bridge circuit formed by the demand, or settable element, and a follow-up element driven by the actuator. The "muscle" of the system is a compact planetary gear-reduced dc motor characterized by high torque for its size and weight. (From applications bulletin No. 2500 included in 18-page catalog, "A.C. and D.C. Motorized Devices," Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.)

For this literature circle 149 on inquiry card.

Frequency Stability Tester

A new microwave frequency stability meter is designed to measure drift and frequency modulation within 1 cps in bands from 10 mc to 10,800 mc in research and maintenance applications. Incorporating a digital discriminator, any change of frequency causes a change in the number of pulses, quantized and shown in cps on the frequency deviation meter.

The frequency of the signal under examination, in addition to its frequency modulation disturbance, is usually drifting. The amplified output of the quantizer,



after filtering and demodulation, drives the drift meter. Interchangeable RF heads allow the instrument to cover either the complete microwave range or a single selected range. Power supply with plug-in RF head is shown on left, indicator unit on right, of illustration. (From 3-page bulletin 5009, Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass.)

For this literature circle 150 on inquiry card.

New Products—Cont.

RUGGED MISSILE POT

New rectilinear potentiometer designed for hydraulic actuator, motor gimbal, and control surface indications operates accurately under vibra-

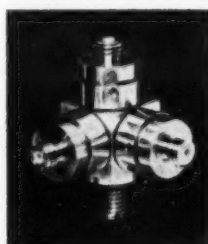


tions up to 20 G in temperatures to 275° F, and shocks to 100 G. Available in 0.5" to 12" ranges, it contains one 10,000 ohm element for telemetering and a 500 ohm element for control.—*Servonic Inst., Inc.*, 640 Terminal Way, Costa Mesa, Calif.

For more information circle 151 on inquiry card.

TRIAxIAL G-GAGE

A new line of tri-axial accelerometers, designed to measure shock and vibration in three mutually perpendicular directions, minimizes installation time and space requirements in tests where three accelerometers are

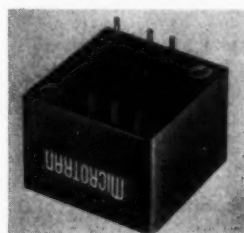


required. Standard 400-TX and miniature 500-TX series use piezoelectric ceramics to feature broad characteristics with sensitivities to 27 mv/G providing responses from 0.03 to 40,000G. Natural frequencies range from 20 to 35 kc for frequency coverage from 1 cps to 12 kc.—*Columbia Research Labs., McDade Blvd. and Bulens Lane, Woodlyn, Pa.*

For more information circle 152 on inquiry card.

TRANSISTOR TRANSFORMERS

Transistor driver and output transformers in molded construction to



meet Mil-T-27A, Class R and S grade 2 or 4, have min reliable life of 10,000 hr. Terminals are for use with dip-soldered printed circuitry.—*Microtran Co., Inc.*, 145 E. Mineola Ave., Valley Stream, N. Y.

For more information circle 153 on inquiry card.

ENCAPSULATED MIL-TYPE TRANSFORMERS

Epoxy resin dipping techniques which do not require "buffer" materials to prevent cracking are being used by DuMont to produce trans-



formers meeting all Mil-T-27A Class B requirements. The new process permits a minimum of epoxy thickness with better moisture protection and better heat transfer, and lower production costs than with conventional potting methods.—*Military Equip. Div., Allen B. DuMont Labs., Inc.*, 760 Bloomfield Ave., Clifton, N. J.

For more information circle 154 on inquiry card.

NO POT NOISE AT 40 G VIBRATION

Linear motion pot with self-aligning feature is said to operate reliably at 40 G up to 2000 cps with error less than 1/2%, without backlash, and with

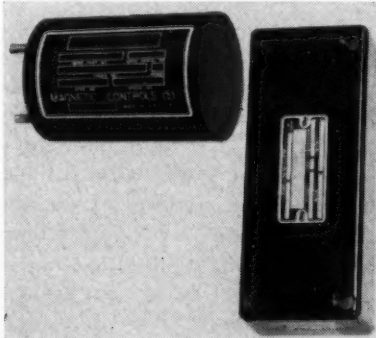


electrical noise not to exceed 0.1% of the total variable resistance or 100 ohms, per NAS-710. Designated Model 157 Align-O-Pot, it's floating shaft permits lateral movement of actuator in missile uses without side-load effect. Available in single or dual outputs and in resistances from 1 to 20 K.—*Bourns Labs., Inc.*, P. O. Box 2112, Riverside, Calif.

For more information circle 155 on inquiry card.

PROPORTIONAL MAGNETIC AMPLIFIERS

Two proportional magnetic amplifiers, identical except for physical con-



figuration, are designed for proportional control of up to 90 watts output with input power of a few milli-

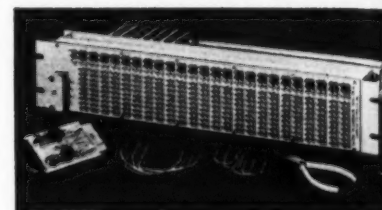
watts. Designated the PA5A (cylindrical) and PA5C (rectangular), the units contain no vacuum tubes, require no shock mounting, and withstand ± 30 G vibration to 2,000 cps and 50G shocks for 11 ms. They operate from standard 115 v 400 cps aircraft or missile power sources, and meet or exceed MIL-E-5272C.—*Magnetic Controls Co., Dept. KP*, 6405 Cambridge St., Minneapolis 16, Minn.

For more information circle 156 on inquiry card.

SERVO & COMPUTERS

PROTOTYPE DIGITAL SYSTEMS

New M-Pac Plugboard Model PB101 lets system designer try out new ideas at least expense, build one-of-a-kind modifications without time

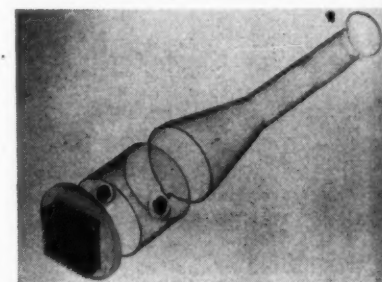


consuming development, and is ideal as teaching aid for digital design classes. Plugboard accepts 24 transistorized 3C-PACs Series M each into its own 12-pin printed circuit connector, connecting to paired jacks shown on front panel. Connections are quickly made and changed by insulated jumpers, plugs.—*Computer Control Co.*, 92 Broad St., Wellesley, Mass.

For more information circle 157 on inquiry card.

MULTI-TARGET COMPUTER TUBE

Storage or high-speed switching functions in computers can be performed using a new cathode ray tube made possible by techniques developed



by the Corning Glass Works. A great number of wires are precisely placed in the tube faceplate, allowing for any combination or series of storage circuits, as each lead plus its supporting elements can store a separate amount of information without using feedback systems. It can also be used as a multiple cathode switch for ultra-speed computer switching circuits. In the unit shown, 256 lead wires are imbedded in 4 sq in of faceplate.—*Corning Glass Works, Corning, N. Y.*

For more information circle 158 on inquiry card.

MILITARY AUTOMATION

TRANSISTORIZED SUMMING AMPLIFIER

New ac input-output summing amplifier for 400 cps operation will find applications in computers, servo systems and computers for bridging and

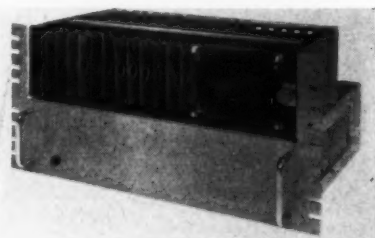


operational amplifiers, scale factors and servo preamplifiers. Transistorized construction provides low power consumption (50 ma at 45 v), high resistance to shock and vibration, 3000 ohm input and 10 ohms output impedance.—Waldorf Inst. Co., Electronics Div., Huntington Station, L.I., N. Y.

For more information circle 159 on inquiry card.

CARD-TO-TAPE TRANSLATOR

New magnetic core memory unit Type 80-CB-7 converts punched-card data in parallel form into serial form for electronic computers, digital con-



trol systems and remote transmission. Stores up to 80 alpha-numeric characters to accommodate standard card, using transistors, diodes and ferrite cores as active elements for high reliability.—Telemeter Magnetics, Inc., 2245 Pontius Ave., Los Angeles 64, Calif.

For more information circle 160 on inquiry card.

AN-DIG CONVERTER/DIGITAL VOLTMETER

New instrument, designated the Voldicon, capable of 2,000 independent analog-to-digital conversions per second; is so fast that a signal ac-



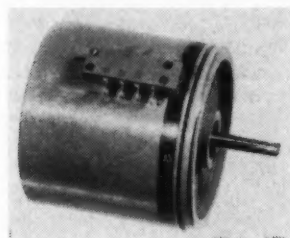
companied by noise is read as brightly seen numerals while the magnitude of random noise values can be estimated by other numbers dimly lit. Analog-digital outputs include visual

display, decimal output for driving typewriters or punches, and binary-coded decimal output and complement for driving most computing elements. At slight additional cost decimal output matrix for arbitrary coding can be furnished.—Adage, Inc., 292 Main St., Cambridge, Mass.

For more information circle 161 on inquiry card.

SOLUTION OF NAVIGATIONAL TRIANGLES SPEEDED

New model PT315 trigonometric potentiometer for analog solution of sine or cosine functions at dc or conventional carrier frequencies over a

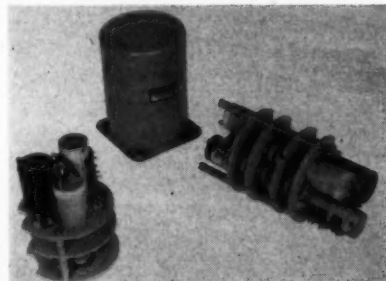


100° range of function. 3", 15-turn units are internally compensated for a specified load so no isolation amplifier is required; achieve conformity of 0.02% for sine or cosine values less than 0.707 and .04% for values over 0.707. Available in hi-temperature (160° C) resistant glass-epoxy or anodized aluminum housings; Class 5 precision ball bearings and ground surfaces assure low torque and long life.—Analogue Controls, Inc., 39 Roselle St., Mineola, N. Y.

For more information circle 162 on inquiry card.

SERVO MECHANICAL COMPONENTS

New line of predesigned mechanisms and servo components include tiny clamp-on gears, anti-backlash gears, pin couplings, and slip clutches.

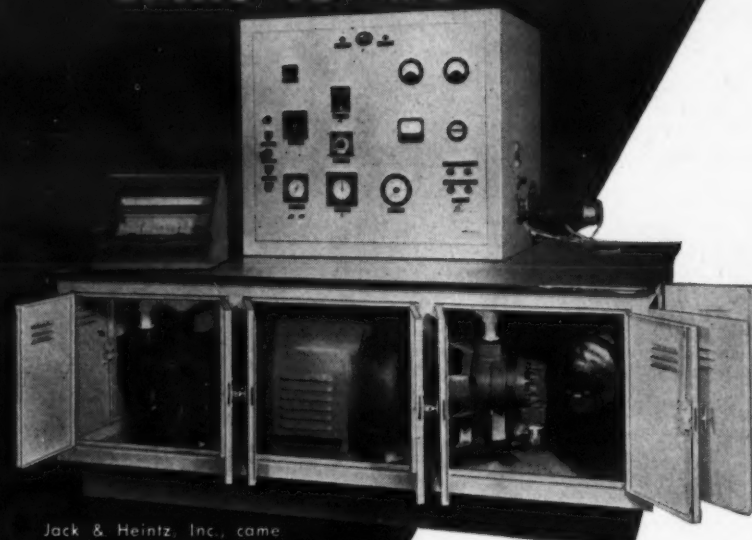


When assembled with ballbearing gearplate assembly and 0.125" dia shafts they form a precision gear box with up to six shaft extensions on either side to accommodate all sizes of servo components. Gearing arrangements can be varied until optimum is reached when unit can be shipped as deliverable equipment, meeting Mil-E-5400 specs. Hermetically sealed enclosures are also available.—Precision Mechanisms Corp., 577 Newbridge Ave., East Meadow, N. Y.

For more information circle 163 on inquiry card.

Need test stands?

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came to IEC



Jack & Heintz, Inc., came to Industrial Engineering Corporation for the design and construction of this electrical actuator test stand for testing Boeing B-52 component parts.

IF your problem is functional test equipment or control panels, Industrial Engineering Corporation can supply the answer. Whether your needs call for the use of hydraulic, pneumatic, electric or electronic principles—singly or in any combination—I.E.C. has the imagination, the ability, the facilities to handle the job right, from original design to actual installation.

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For more information circle 21 on inquiry card.

Electronic Circuitry for Instruments and Equipment

by MILTON H. ARONSON
Editor,
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"As a comprehensive source book on instrument circuitry, this one will be hard to beat."
... Sept. issue of RADIO & TELEVISION NEWS

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A complete home-study TEXT and COURSE, with 458 multiple-choice home-study test items on basic electronic circuitry for instruments, communications, TV, laboratory apparatus, and military equipment. (Printed serially in Instruments as "Instrument Electronics.")

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Enclosed is \$..... for copies of Aronson's ELECTRONIC CIRCUITRY for INSTRUMENTS and EQUIPMENT at \$2.00 each postpaid.

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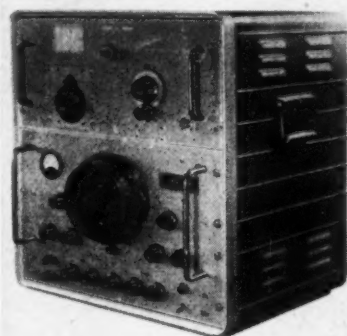
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taneously to 100 magnetostriction filters which cross over at 3 db and the output of each filter is sampled in sequence. Out-of-phase summation of scanned outputs cancels noise and provides frequency resolution to distinguish signals 60 cps apart. Applications include study of satellite signals, telemetering, transmission jamming, tube microphonics, and transmission of coded frequencies.—*Kay Electric Co., Maple Ave., Pine Brook, N. J.*

For more information circle 173 on inquiry card.

RF SPECTRUM ANALYZER

Analysis of radar, radio relay and other signals in the 2400 to 9600 mc range to an accuracy of $\pm 0.08\%$, plus evaluation of high VSWR, leak-



age and loss conditions, are accomplishments of new Spectrum analyzer designated PRD Series 860. The basic power supply and indicator unit, Type 860-I, includes IF amplifier and 5" oscilloscope display for use with any of four RF heads. IF characteristics: 1st IF center frequency, 40 mc; 2nd IF, 5 mc; less than 30 kc bandwidth; over 60 db attenuation; 3-30 cps min spectrum sweep range; and linear spectrum amplitude display.—*Polytechnic Research & Development Co., 202 Tillary St., Brooklyn 1, N. Y.*

For more information circle 174 on inquiry card.

CHECKS RADAR SWEEP FIDELITY

New type 1105 Radar-Video sweep generator provides instrumentation



for testing of frequency-amplitude characteristics of wide band circuitry, including radar amplifiers and filters. Video frequency sweep from 50 kc to 10 mc; output adjustable from 1 mv to 2 v peak-to-peak; 1 to 10 mc points are marked by ten crystal-controlled markers of 0.01% accuracy.—*Tel-Instrument Electronics Corp., Dept. W, 728 Garden St., Carlstadt, N. J.*

For more information circle 175 on inquiry card.

VARIABLE ULTRASONIC DELAY

A delay medium of fused quartz driven by a precision mechanical system provides a wide variety of delay ranges for special applications, in-

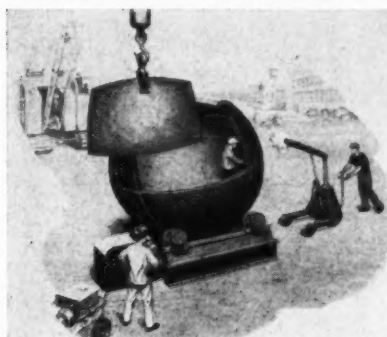


cluding target simulators, where accurate setting of delay time is essential and band width is required.—*Andersen Laboratories, Inc., 501 New Park Ave., West Hartford, Conn.*

For more information circle 176 on inquiry card.

COBALT 60 RADIOGRAPHIC UNIT

New Cyclops radiographic unit contains Cobalt 60 radioactive source in steel-jacketed lead sphere with remote-controlled shutter which permits



personnel to supervise radiography at safe distance. 5"-thick steel can be radiographed for flaws in 6 minutes with unit that can move to the job even on out-side construction sites.—*Picker X-Ray Corp., 25 S. Broadway, White Plains, N. Y.*

For more information circle 177 on inquiry card.

BLACK BODY I-R STANDARD

New black-body infrared source and calibration standard, Model RB-1, features an extended area (2 1/8" dia) with special Fresnel surface. Operat-

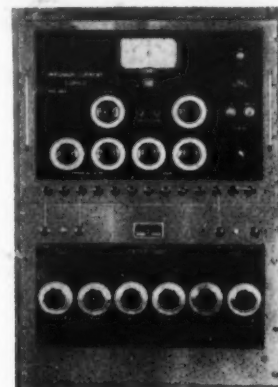


ing over temperatures from 60° to 500° C with an axial emissivity over 0.99, the unit also incorporates a direct-reading temperature controller. Operation requires 210 watts at 115 v, 60 cps.—*Radiation Electronics Corp., 8241 N. Kimball Ave., Skokie, Ill.*

For more information circle 178 on inquiry card.

PRIMARY STANDARD POTENTIOMETER

New voltage current instrument, incorporating a standard cell reference, voltage divider, and resistance standards; achieves accuracy of

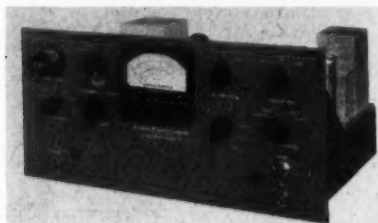


0.0015% in voltage measurement and 0.003% in current measurement. Standard cell reference, accurate to 0.001%; and voltage divider, accurate to 0.001%, can be used separately as lab standards.—*Julie Research Labs., Inc., 556 W. 168 St., New York 32, N. Y.*

For more information circle 179 on inquiry card.

INTEGRATOR FOR WAVE ANALYSIS

Power spectral density analysis of random waves is speeded by new unit,

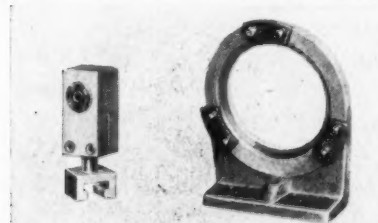


TP-633 Power Integrator, that accepts IF output from the Analyzers, producing a dc analog proportional to power spectral density.—*Technical Products Co., 6670 Lexington Ave., Los Angeles 38, Calif.*

For more information circle 180 on inquiry card.

SERVO SHAFT HANGERS

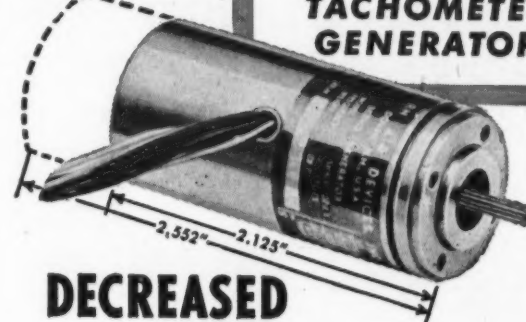
New precision component and shaft hangers are designed for servo and for prototype and production applications. Single and double bearing type



hangers for 1/4" and 1/8" shafts, and blank hangers for mounting non-standard components can be supplied.—*Reeves Instrument Corp., 207 E. 91st St., New York 28, N. Y.*

For more information circle 181 on inquiry card.

EAD's New Size 11 Servo TACHOMETER GENERATOR



DECREASED
SIZE...
INCREASED EFFICIENCY

Precision,
Performance,
Price—
Get all 3
at EAD

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EAD's precision size 11, 115-volt motor tachometer is now available in a smaller package—and achieves improved electrical characteristics! It delivers 0.6 volts per 1000 rpm with 19 millivolts of total null. Lower nulls are available. Upper temperature reading is 150°C. EAD's new unit is available in variations of voltages and power ratings for transistor operations, variations in shaft and mounting configurations, etc... and may be ordered with precision gear heads to your requirements. Write for more information.

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For more information circle 22 on inquiry card.

New
Engineering
Handbook on



TEFLON*

Fully describes its advanced usage as a cushioning and insulating material for wire and tube supporting clamps.

Send now for your copy of this new 20-page illustrated "TX" Engineering Handbook on Teflon* (Tetrafluoroethylene). Contains all latest information on Teflon* including chemical, thermal, electrical and aging properties as well as modern methods of handling it. Illustrates seven models of Teflon* cushioned support clamps which are available in 18 standard types. Included is a comprehensive tabulated chart covering 28 tests, furnished courtesy of the Du Pont Company. Write today for free copy.

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TA MFG. CORP.

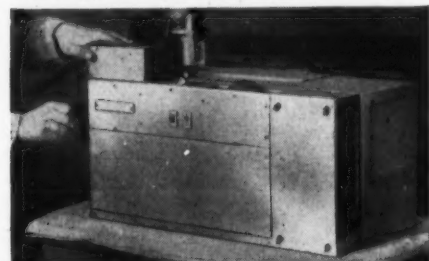
4607 ALGER STREET • LOS ANGELES 39, CALIFORNIA

For more information circle 23 on inquiry card.

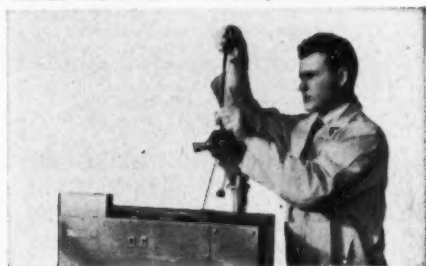
New 16mm. processor

DEVELOPS FILM AT SIX FEET A MINUTE

Speedy, commercial quality processing of 16 mm. film, without the use of a dark-room, is now possible with Fairchild's "Mini-Rapid 16" Processor. Here's how you can process a 100-foot roll of film, "from shooting to screening," in just 20 minutes.



1. Minutes after shooting, a 100-foot film spool is dropped into the feeding compartment. To develop, the operator simply feeds the first few inches into a slot in the compartment.



2. Less than two minutes later, the first few feet emerge, dry and ready for inspection. The operator can adjust to compensate for exposure or chemical temperature variances simply by turning the drive speed control knob.



3. After another fifteen minutes, the 100-foot roll is completely developed—another three minutes to load projector and it's ready for screening!

If you require commercial quality negative processing of 16 mm. film for immediate viewing—service never before possible—investigate Fairchild's new "Mini-Rapid 16" Processor. It's already in demand by industry and television.

For a demonstration in your own plant or office, write Fairchild Camera and Instrument Corporation, Industrial Camera Division, Dept. 9X, 5 Aerial Way, Syosset, Long Island, New York. West Coast Office: 6111 East Washington Boulevard, Los Angeles, California.

FAIRCHILD
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CORPORATION

For more information circle 24 on inquiry card.

Optics, Radio, Infrared and Hi-Temp Systems Use Sapphires



FIG. 1. SINGLE SAPPHIRE crystals now can be grown up to 5 1/2" diameter. Finished windows and lens shown with rough crystals from which they are polished.

Extreme hardness and ability to take a smooth polish make sapphire (alumina single crystals) ideally suited for critical wear applications, such as wear guides in tape recorders, camera film guides and phonograph needles.

Like sintered aluminum oxide, sapphire is an excellent insulator and a low-loss dielectric material from low frequencies up to the microwave region. As an insulator in vacuum systems, sapphire has the advantage over sintered alumina in that it has zero porosity and so does not outgas. These properties make sapphire ideally suited for output windows in microwave tubes such as klystrons and magnetrons, internal supports for vacuum tubes, insulators, and low-leakage capacitors. Single crystals to 5 1/2" diameter are now grown.

The optical transmission of sapphire runs from within the ultra-violet region (1450 Angstroms) to

SOME PROPERTIES OF INDUSTRIAL SAPPHIRE

Composition	100% aluminum oxide		
Finish	Optically clear or frosted		
Melting Point	2040°C		
Hardness	Knoop: 1525 to 2000; Mohs: 9		
Specific Gravity	3.98		
Thermal conductivity	0.065 calories/cm ² /sec/°C/cm at 100°C.		
Electrical Resistance	500°C	1000°C	1500°C
	10 ¹¹ ohm-cm	10 ¹² ohm-cm	10 ¹³ ohm-cm
Optical Transmission	Ultra-violet (Sample 2mm thick) 66% at 2000 Angstrom 20% at 1500 Angstrom		
	Infrared (Sample 1 mm thick) 92% at 3 microns 50% at 6 microns		

the intermediate infrared region (6 to 7 microns). Also, its usable transmission characteristics in the infrared go up to 1500°C. Thus, sapphire has considerable potential in specialized optical applications; for example, the exterior window of military infrared equipment, missile domes, optical windows in high pressure or high temperature systems; lenses where its low dispersion and high resistance to abrasion is needed; and in gaseous discharge lamps where its resistance to crazing from electrical discharge and desirable ultraviolet transmission characteristics are required. Particularly interesting is the use of a sapphire rod as a radiation tube to bring infrared radiations from a heated target to a sensitive detector which can be placed in a cooler area.—(From 4-page brochure, "Properties and Uses of Linde Sapphire", by Linde Co. Div. of Union Carbide Corp., 30 E. 42nd St., New York 17, N. Y.)

For this literature circle 182 on inquiry card.

High Level Diode SSB Modulator

In CW radars and many types of test equipment standard mixer diodes are being used at elevated average power levels of up to 150 mw per diode to amplitude-modulate microwave carriers at relatively high modulation frequencies to obtain single sideband outputs.

The safe operating power level is a function of the crystal dc load resistance. As failures are often due to excessive crystal peak inverse voltage, it is recommended that dc loads be held to the lowest possible values. In a typical modulator application two diodes are inserted in diode holders (Fig. 1) mounted on opposing arms, A and B, of a magic tee (Fig. 2) with an RF carrier injected into a third arm, C. Modulation voltage is applied across what would normally be considered the IF output load through a suitable transformer. The use of one reversed-polarity diode paired with one of forward polarity allows the carrier and IF signals to be supplied in the same relative phase, thus generating sidebands in phase opposition which add

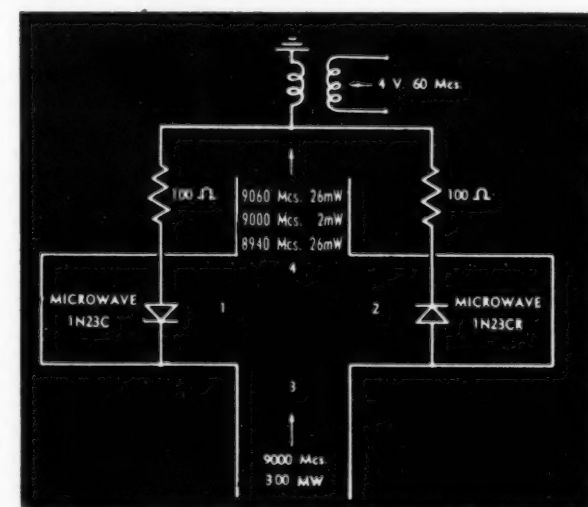


FIG. 1. SCHEMATIC OF MAGIC tee modulator provides 26 milliwatts in two sidebands from 300 milliwatts input. Carrier is attenuated.

in the fourth or output arm, D, of the mixer. The carrier is appreciably rejected by the magic tee, but filtering (using standard microwave bandpass techniques) is necessary to eliminate the undesired sideband.

Although the 100-ohm resistors shown (Fig. 3) limit the dc reverse voltage to a safe value, somewhat larger values are commonly used. In a practical case, their value is adjusted for maximum sideband power output, and values to 1000 ohms are permissible.

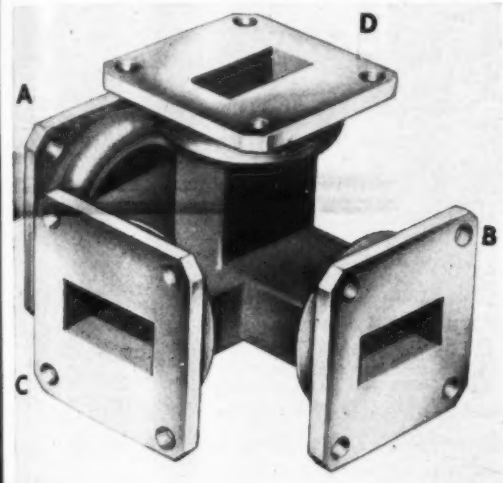
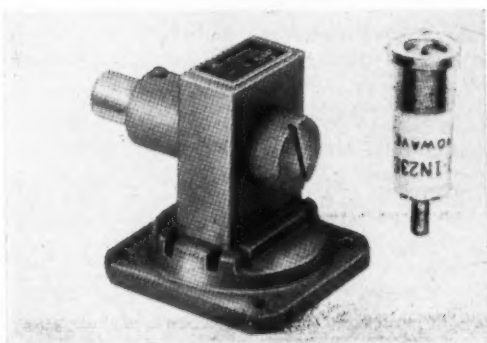


FIG. 2. MAGIC TEE, Model MA-541; diode holders fit on arms A and B; C is input arm and outputs are taken from D to antenna.

FIG. 3. DIODE HOLDER Model MA 536A and 1N23 E diode for 9 kmc band.



These diode ground returns need not be a part of the 60-mc circuitry; ordinary filtering techniques may be used to isolate them.

Frequency range: Depends upon waveguide components used; 8.5 to 9.6 kmc with hardware shown.

Modulation bandwidth: 60 mc SSB.

Power level: Approx. 26 mw in single sideband from 300 milliwatt input to modulator.

Impedance: The modulating transformer impedance will depend on the impedance of the 60-mc generator. At the power levels indicated, the diodes will represent a 60-mc impedance of the order of 100 ohms. The transformer must match this level to the output impedance of the 60-mc source. If higher resistor values are used the match must be adjusted accordingly.

Conversion efficiency: The conversion efficiency of a diode modulator system depends directly on the conversion loss of the diodes used. Efficiencies of approximately 10 db may be expected. For top performance the low-noise types 1N23E or 1N21E should be used. The 1N21 series is preferable for higher power use.

Source: Mr. Howard I. Ellowitz, Chief, Diode Eng. Section, Microwave Associates, Inc., Burlington, Mass.

For more information on Microwave hardware mentioned circle 183 on inquiry card.

2-Gyro Master For Jets

A new Two-gyro Master Reference is now available to provide precise stable signals simultaneously to flight indicator, automatic pilots, fire control systems, navigation systems and other instrument receptors aboard new Air Force and Navy jet planes. Through the elimination of many separate stable elements previously required, savings in weight, space and cost are possible.

The Lear Model 2171 Master Reference (Fig. 1) combines a directional and a vertical gyro on a common "no-gimbal-lock" type suspension. All modern military aircraft use directional gyros to provide a stable indication of aircraft heading during turn-type maneuvers. The conventional directional gyro, however, is limited when the jet performs maneuvers requiring high pitch angles, and azimuth errors of 5° to 10° are common. The Lear two-gyro reference stabilizes its directional gyro by holding it in its normally horizontal position through all types of maneuvers, reducing errors to a fraction of a degree. Random drift is very low; has been tested at rates less than $1^\circ/\text{hr}$ when magnetic heading control is removed.

The vertical gyro has a dual function; (1) providing non-tumbling roll and pitch (elevation) signals for flight instruments, or (2) for automatic control systems. No-gimbal-lock design of the vertical gyro

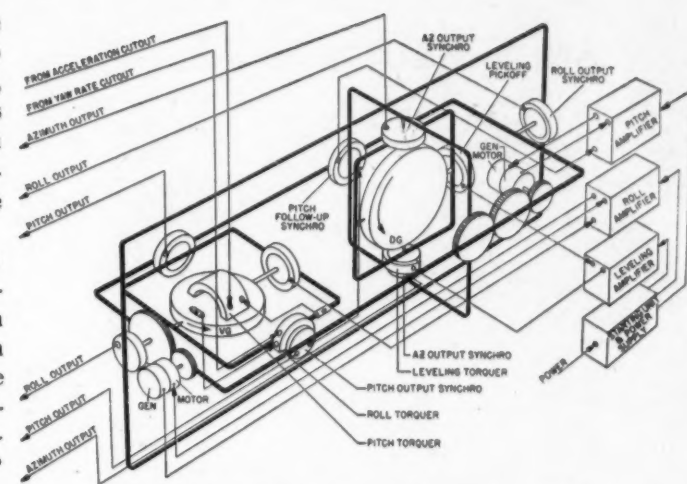


FIG. 1. MASTER COMPONENT provides stable signals to all plane's instruments.

allows its full 360° freedom in pitch or roll, providing accurate stabilization information during loft bombing and sustained near-vertical flight.

The two-gyro system is contained in a $6\frac{1}{2}'' \times 6\frac{1}{2}'' \times 13''$ package weighing only 19 lbs and is tested under random noise type vibration at 10 G, 10 to 2000 cycles, and 10 G shocks. It is a development of Lear, Inc., 110 Ionia Ave., Grand Rapids, Mich.

For more information circle 184 on inquiry card.

Quartz Standard Has Unusual Stability

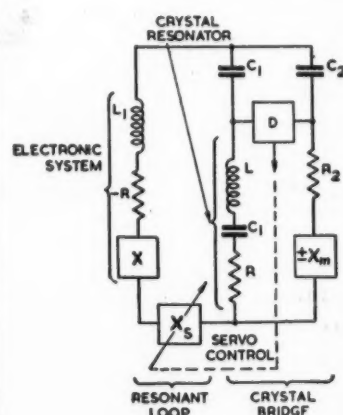


FIG. 1. RESONANT-LOOP and RF-bridge balancing combine to hold frequency to a few parts in 10^{11} .

New Marconi Type RD 101 Frequency Standard employs a high-precision 5 mc quartz crystal in combination with a servo system which eliminates instabilities arising from the inherent reactances of valves (tubes) and associated components. As the servo corrects errors in excess of a few parts in 10^{11} , the equipment provides the highest stability attainable with a quartz resonator.

Two forms of stabilization, namely by resonant loop vector balance and by RF bridge balance, may be used simultaneously, as shown in Fig. 1. This arrange-

ment includes three additional (stabilizing) components; namely in inductance L_1 to balance the reactance of C_1 in the resonant loop, a periodically varying reactance $\pm X_m$ for the purpose of exploring the relation to bridge balance, and a correcting reactance X_s which may be controlled by an error signal obtained from the detector D . . . The effective modulating reactance X_m of Fig. 1 is achieved by 75 cps voltage variations relative to a dc bias on a capacitor having variable permittivity. If the RF is identical with the frequency of the crystal, the latter will behave as a pure resistance and the bridge will be balanced at every zero position of the 75 cps modulation voltage. In this condition the bridge demands no change of frequency with departures from exact R-balance. When the RF is incorrect, an error signal drives a two-phase motor supplied with a fixed quadrature 75 cps reference to apply an appropriate correction. Overall frequency stability attained is within 2 parts in 10^{10} , with drift compensation. Outputs are 10 mc, 1 mc and 0.1 mc, discrete, at a minimum of 1 v rms. (From 12-page Technical Description TD-204 by Marconi's Wireless Telegraph Company Ltd., Marconi Instruments, 111 Cedar Lane, Englewood, N. J.)

For this literature circle 185 on inquiry card.

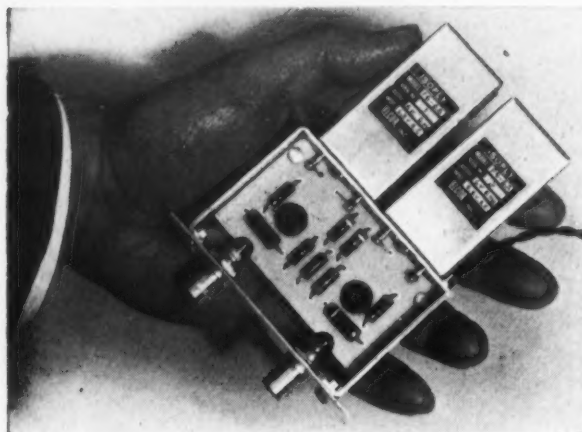


FIG. 1. NEW "ISO-PLYS" (isolated power supplies) provide efficient coupling sub-circuit isolation supplying power in modular designs.

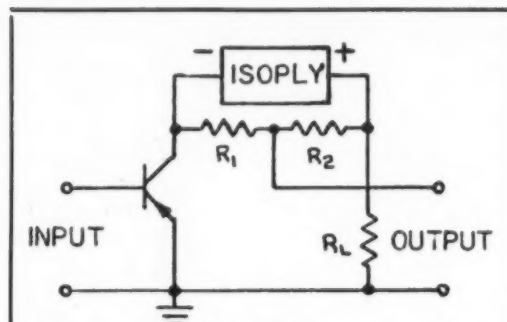


FIG. 2. SINGLE ISOPLY used as direct coupling element.

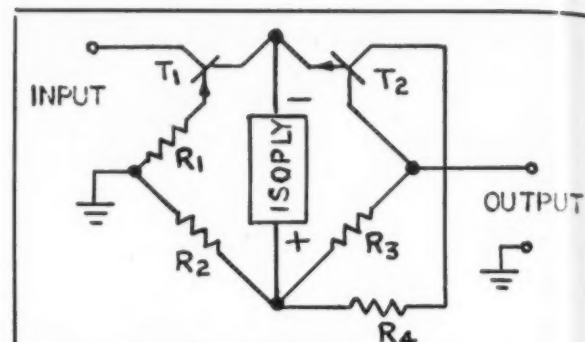


FIG. 3. BRIDGE AMPLIFIER powered by Isoply has output stable with respect to ground.

Subminiature Power Packs Simplify Transistor Circuits

A new Zener-regulated isolated power supply unit, scaled to supply transistor collector-circuit loads and designated the "Isoply," is now available in ratings from 9 ma at 4 vdc to 11½ ma at 26 v dc. Having a shunt capacitance to ground of only 20 μμf, the Isoply can be used as a means of direct coupling in high-speed circuits and as a power source in bridge circuits, modular units or subassemblies, and small instruments. Fig. 1 shows two Isoplys providing power in a modular rectangular wave generator requiring only 6.3 v 60 cps input.

A circuit in which direct coupling is achieved by the use of the subminiature power supply is shown in Figure 2. This method has greater stability than conventional voltage-divider or Zener-diode methods of direct coupling and is also less critical with respect to the values of components used. A bridge dc amplifier having good stability is shown in Figure 3. Here transistor T2 provides a compensating effect for ambient temperature changes. The circuit is also relatively insensitive to supply voltage changes and provides an output voltage that is stable with respect to ground.

An advantage of using Isoplys in modular construction is the unusual ease with which such modules can be interconnected to synthesize a system. Since each module is complete with its own d c power supply there is no possibility of interaction between modules through a common power supply, and hours normally spent in decoupling, by-passing dc power leads, and in troubleshooting unwanted interaction between circuits are saved. The total cost of separate subminiature power supplies is often less than that of a high-current regulated common supply. Another factor is the inherent simplicity and stability of circuits supplied by isolated power supplies which means that a higher potential of reliability exists. Laboratory experience with these circuits indicates that more extensive use will substantiate this claim of higher reliability. (From 4-page bulletin, "Application Notes,"—Elcor, Inc., P. O. Box 354, McLean, Va.)

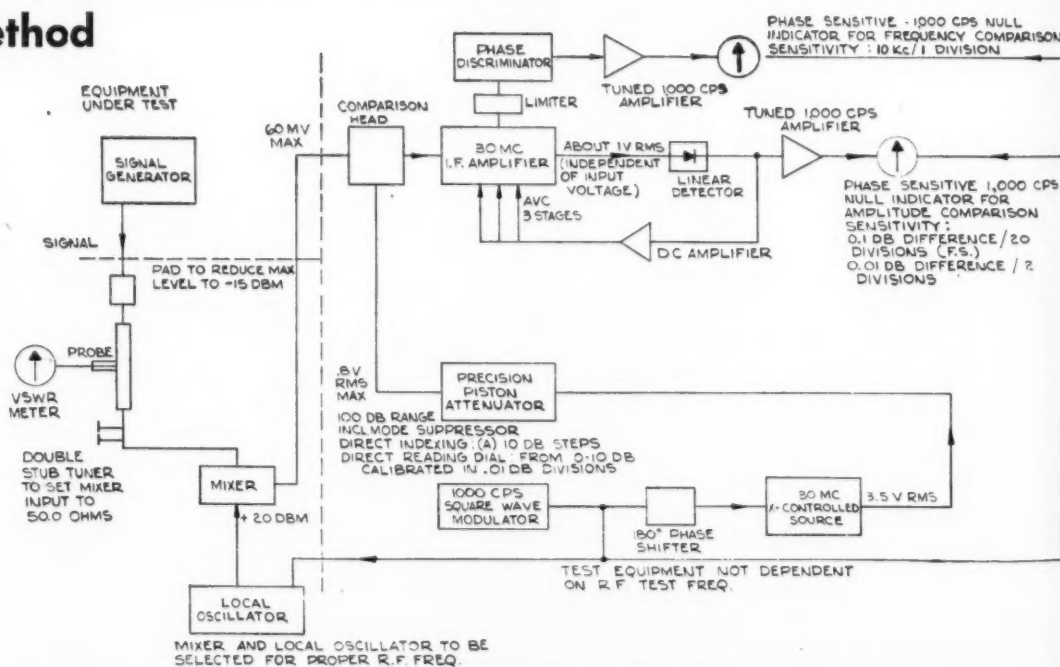
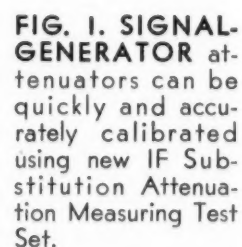
For this literature circle **186** on inquiry card.

Attenuation Measurement IF Substitution Method

The IF Substitution Attenuation Measuring Test Set schematically shown in Fig. 1 makes available in a single setup all the equipment needed to quickly calibrate signal generator attenuators without sacrificing accuracy. After the initial setup at a fixed frequency a semi-skilled operator can calibrate six 10-db steps of an output attenuator in about two minutes. It is also possible to quickly calibrate two points 70-db apart at the high and low ends of the attenuator without performing the entire operation.

A 1000-cps square wave is used to alternately supply a standard signal and the signal from the attenuator to be measured to a 30-mc amplifier. Two outputs from the amplifier are applied (1) through a limiter and a frequency discriminator which drives a frequency null indicator; and (2) from a linear detector which provides AGC voltage and signal to an amplitude null indicator.

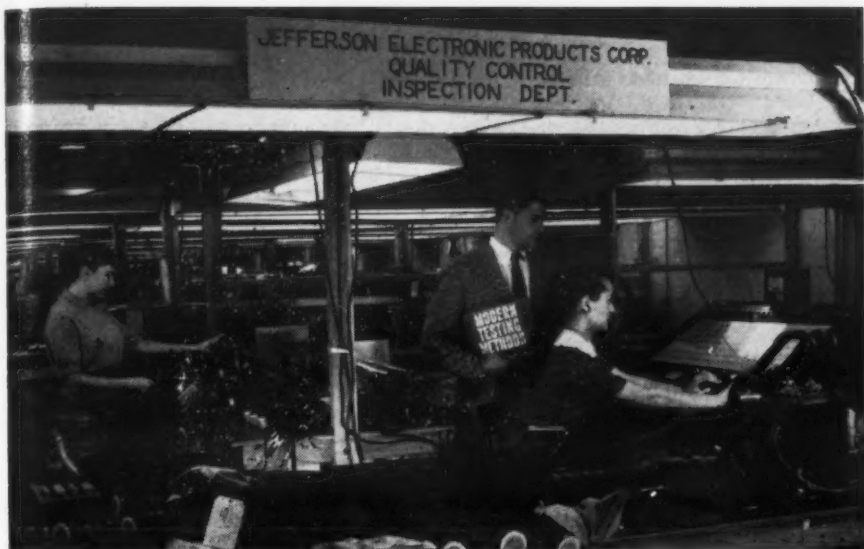
It is necessary that the two signals be at the identical frequency to insure that the amplifier will give both signals the same amplification. Accordingly, the first step is to adjust the frequency of the local oscillator until the frequency null indicator shows a null. The next step is to adjust the precision piston attenuator until a null is also read on the amplitude null indi-



cator. The difference in the setting of the piston attenuator for two different levels of the unknown signal indicates the ratio of these two levels. If one of these levels is known absolutely as a result of an independent measurement on a power bridge the other also is known as a result of the ratio meas-

urement. In the case of attenuation measurements the ratio of signal levels with and without the unknown attenuator in the line gives the attenuation directly. (From 7-page Bulletin No. 102, *IF Substitution Measurement Test Set*," Weinschel Engineering & Mfg. Corp., 10503 Metropolitan Ave., Kensington, Md.)

For this literature circle **187** on inquiry card.



MODERN TESTING METHODS Assure Product Reliability and Quality for Jefferson Electronic

DIT-MCO Circuit Analyzers Automatically Detect Finite Flaws in Highly Complex, Multiple Interconnected Circuitry

A simple, efficient system for planning, performing, controlling and recording the complete test cycle of any electronic or electrical circuitry has been developed by DIT-MCO, Inc., Kansas City, Missouri. This revolutionary concept can virtually eliminate electrical circuitry errors, both in assembly line and custom manufacturing operations. In action at the Jefferson Electronic Products Corporation, of Santa Barbara, California, it provides the exacting quality control and reliability which have helped to make the company's products famous. In addition to quality control and universal application, the system improves interdepartmental communications, facilitates coordination and provides up-to-the-minute test information at any stage of planning, production or maintenance.

This new testing system is built around the DIT-MCO Circuit Analyzer, a highly accurate, automatic circuit tester which makes rapid, sequential tests of any complex,

multiple interconnected circuitry. The basic model tests up to 200 circuits in twenty seconds, and test capacity can be enlarged to any required degree by adding multiplier sections. It detects potentially dangerous, finite wiring flaws by simultaneously testing one wire against all others commoned together... without special connections. All external resistive devices are automatically energized and functionally tested, and circuits connected together at common terminal points are thoroughly checked. The Analyzer never requires internal modification and easily adapts to any test by use of adapter cables. The exclusive DIT-MCO Matrix Chart pinpoints error location, circuit number, type and amount of fault, enabling technicians to make corrections without reference to manuals or diagrams. Standard, telephone-type components give years of trouble-free service with minimum maintenance. Nontechnical personnel easily master operation with less than one-half hour's instruction.

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"Modern Testing Methods" tells how DIT-MCO's comprehensive electrical or electronic testing system can save time and increase the reliability of your product. It offers a practical, tested plan for standardizing and improving your testing methods. It's yours for the asking, without obligation. Send your name, title, and company address to:

DIT-MCO INC. ELECTRONICS DIVISION

Box 06-27, 911 Broadway

Kansas City 5, Missouri

Partial List of DIT-MCO Users:

Aircraft Radio Corp. • AirResearch Manufacturing Co. • American Bosch Arma Corp. • American Machine & Foundry Co. • American Motors • Amphenol Electronics Corp. • Autonetics, A Division of North American Aviation, Inc. • Bell Aircraft Corp. • Bendix Aviation Corp. • Boeing Airplane Co. • Cessna Aircraft Co. • Chance Vought Aircraft, Inc. • Chrysler Corp. • Convair • Douglas Aircraft Co., Inc. • Dukane Corp. • Electronic Products Corp. • Fairchild Aircraft Division • Farnsworth Electronics Co. • Frankford Arsenal • General Electric Co. • General Mills, Inc. • Mechanical Division • General Precision Laboratory, Inc. • Goodyear Aircraft Corp. • Grumman Aircraft Engineering Corp. • Hazeltine Electronics Division, Hazeltine Corp. • Hughes Aircraft • International Business Machines Corp. • Jefferson Electronic Products Corp. • Lockheed Aircraft Corp. • Missile Systems Division • Martin, Baltimore • Minneapolis-Honeywell, Aeronautical Division • Motorola, Inc. • Northrup Aircraft, Inc. • Pacific Mercury Television Mfg. Corp. • Radio Corp. of America • Radioplane Co. • Raytheon Manufacturing Co. • Servomechanisms, Inc. • Sikorsky Aircraft • Sperry Gyroscope Co. • Summers Gyroscope Co. • Sun Electric Co. • The Swartwout Co., Autronic Division • Temco Aircraft Corp. • Thompson Products • Topp Industries Inc. • Trans World Airlines • U. S. Naval Air Station Overhaul and Repair Depots • U. S. Naval Ordnance Laboratory, White Oak • Vertol Aircraft Corp. • Western Electric Co. • Westinghouse Electric Corp.

For more information circle 27 on inquiry card.

Gaussmeter Uses Hall Effect

Model D-79 Gaussmeter, which directly reads magnetic fields from 10 to 30,000 gauss, uses a sensing area only 0.070" diameter located near the tip of its probe. Because this active area is so small, the instrument is ideal for locating inhomogeneities in dc magnetic fields, as required in many areas of magnetic research.

Using the "Hall effect" principle, the probe is balanced by means of the front panel controls. When the probe is inserted in a magnetic field the bridge is driven off balance in proportion to the strength of the magnetic field. Both ac (rms) and dc fields

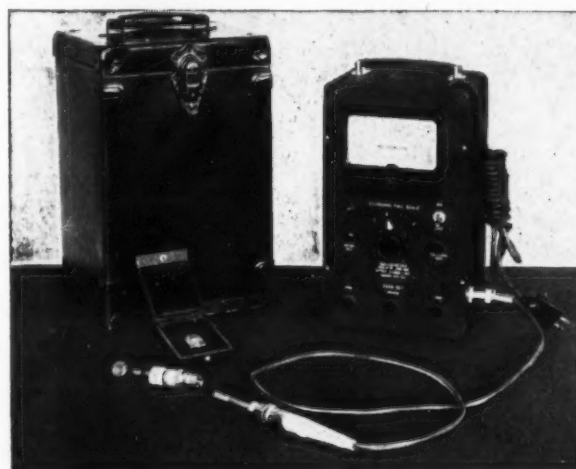


FIG. 1. HALL EFFECT, which provides an output voltage proportional to product of control current and magnetic field perpendicular to it in the sensing crystal, is used in the Model D-79 Gaussmeter.

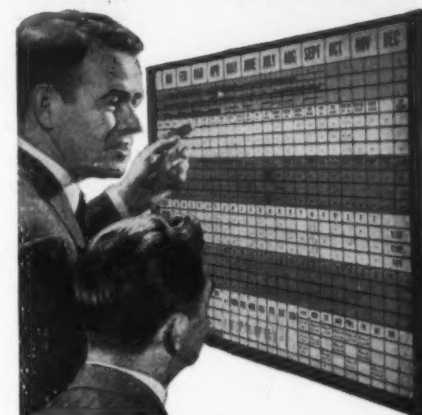
can be read without distortion of the field. While the primary use of the gaussmeter is to measure flux density in magnitude and direction, other related uses are to determine flux paths, locate and plot leakage fields, and locate and measure variations in a magnetic field. Although ac fields can be accurately measured to 400 cps, comparative readings can be made to 1000 cps.

Direction of the field is easily determined because the probe is highly directional. Accuracy is $\pm 1\%$. The calibrated magnetic air gap supplied with the meter is accurate to $\pm 1\%$ of value indicated, and can be used to check the calibration of the meter at extremes of ambient temperature.

The D-79 Gaussmeter is highly portable, requiring only 75 watts, 105-125 v, 50-60 cps power. Two probes are supplied, one with high sensitivity for measurement of low density fields, and one is linear for measurement of high density fields. They can be furnished either round or flat and to any desired length. The D-79 Gaussmeter is a development of Dyna-Empire, Inc., 1075 Stewart Ave., Garden City, L. I., N. Y.

For more information circle 188 on inquiry card.

You Get Things Done With Boardmaster Visual Control



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GRAPHIC SYSTEMS

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For more information circle 28 on inquiry card.

NORTHAM

HIGH SENSITIVITY, LOW RANGE
PRESSURE TRANSDUCER



An extremely sensitive variable inductance instrument for measurement of steady and transient pressure in full scale ranges as low as ± 4 inches of water. Permissible pressure overload in either direction up to maximum line pressure, 100 psi, for difficult flow-metering applications. A light diaphragm sensing element free from external mechanical linkage results in high natural frequency for dynamic measurements.

MODEL DP-7 SPECIFICATIONS:

Pressure Ranges: ± 0.15 to ± 15 psid
Maximum Line Pressure: 100 psi
Accuracy: $\pm 1\%$ full scale
Excitation Frequency: From 60 to 20,000 cps
Natural Frequency: From 250 cps for 0.15 psi range to 2500 cps for 15 psi range

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Northam Engineering Facilities Are Available To Assist You With Any Application Problems.

NORTHAM PRODUCTS INCLUDE...

Transducers for pressure, acceleration and displacement measurement and auxiliary electronic equipment for complete systems.

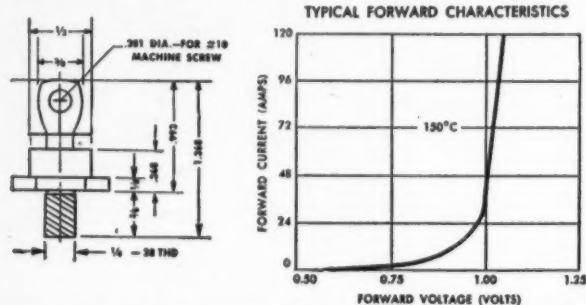
NORTHAM ELECTRONICS, INC.

A Subsidiary of Norris-Thermador Corp.
2420 North Lake Avenue, Altadena, Calif.

For more information circle 29 on inquiry card.

Silicon Hi-Power Diodes

New P3000 series heavy-duty diffused-junction silicon power diodes are conservatively rated, with an ambient temperature range of -65° to 150°C . Featuring solid copper construction for maximum electrical conductivity and heat dissipation, they are reliable components for new or replacement design. Electrical specs include: Max average forward current of 6

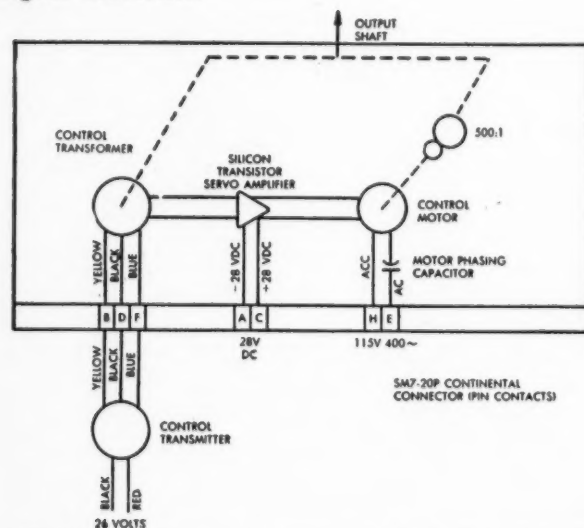


amp (half-wave, single phase, resistive load, 40°C ambient) in free air with no heat sink; 30 amp with 6" x 6" heat sink in free air; 60 amp with 6" x 6" heat sink 1000 cfm air. Piv of the P3000 series range from 50 to 400 v. (From Eng. Data Sheet P3000 Series, one of five data sheets covering silicon power diodes from 10 to 30 amp rating. Thermosen, Inc., 375 Fairfield Ave., Stamford, Conn.)

For this literature circle 189 on inquiry card.

Miniature Servo

The Model 100-1 Servo, although primarily designed for servo repeater applications, also fulfills the system designer's need for an isolation servo between synchro components or a synchro-controlled servo drive for resolvers, potentiometers, or shaft-to-digital converters.



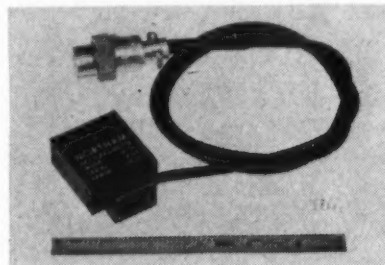
Within a package 3" long by $1\frac{3}{4}$ " diameter, the servo includes: Motor control transformer, amplifier, gear train and related circuitry. It receives its input signal from a standard control transmitter, control transformer or differential generator, and delivers shaft output information. (From 2-page bulletin 100-1, Librascope, Inc., a Div of General Precision Equipment Corp., 808 Western Ave., Glendale, Calif.)

For this literature circle 190 on inquiry card.

New Products—Cont.

ACCELEROMETER FOR BALLISTOCARDIOGRAPHY

Medical research in the displacement of the human body as it reacts to pumping action of the heart, with the patient supported on a light sus-

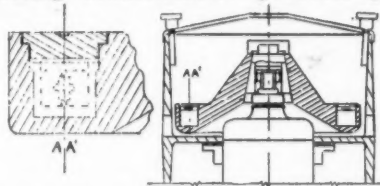


pended bed carrying a sensitive accelerometer, is aided by a new Northam Model A-14 transducer, with a sensitivity of full scale output at ± 0.5 G which may be used with direct writing recorders. The A-14 uses the variable reluctance principle, operating with a 3 v 3000 cps excitation to give a nominal output of 50 mv/v.—Northam Electronics, Inc., 2420 N. Lake Ave., Altadena, Calif.

For more information circle 191 on inquiry card.

TRANSISTOR CENTRIFUGE TEST

New accessory for CSI hi-speed angle centrifuge is special rotor for testing semiconductor products per

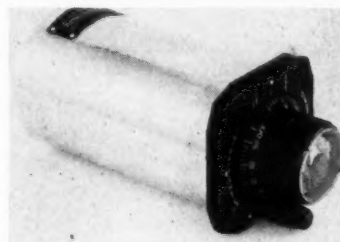


MIL-T-19500A. Rotor is available in 4, 6 or 8 place capacities.—Custom Scientific Instruments, Inc., 541 Devon St., Kearny, N. J.

For more information circle 192 on inquiry card.

CAMERA TIMER

Cameras in chase aircraft for recording test flights of supersonic targets are timed by new Gordent Type 15A intervalometer. Pulsations



can be varied from $\frac{1}{2}$ -60 sec intervals. Either single frame or cine operation can be remotely controlled. Now available for non-military uses.—Gordon Enterprises, 5362 N. Cahuenga Blvd., N. Hollywood, Calif.

For more information circle 193 on inquiry card.

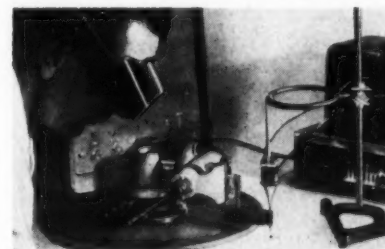
COMPONENT TEST FACILITIES

Complex waveform types of vibration generated by modern rocket engines are comprehensively simulated by new sinusoidal and random vibration systems combined with environmental, electrical, electronic, pneumatic, mechanical, hydraulic and cryogenic functional tests. Latest vibration system includes MB C-25 3500-lb exciter powered by a Ling 20/20C amplifier, Ling peak-notch filters, equalizers, G-R random noise generator, Moseley x-y plotter and accessories.—Wyle Associates, 128 Maryland St., El Segundo, Calif.

For more information circle 194 on inquiry card.

3-D MAGNIFIER GUIDES PRECISION WORK

Magni-Focuser, new binocular type magnifier, is used by Lockheed Missile Div. technician to monitor new ultrasonic precision drill devised to

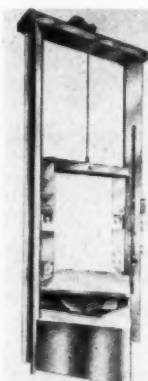


pierce hard materials with 0.005" holes. Magni-Focuser gives magnified vision in third dimension, leaves hands free.—Edroy Products Co., 480 Lexington Ave., New York 17, N. Y.

For more information circle 195 on inquiry card.

SHOCK TESTER

Shock tests capable of precise reproducibility from 20 to 250 G with time durations of from 3.0 to 30.0 milliseconds are provided by new



Model S-200-V Jolta Universal shock testing machine. Single-unit carriage table will accommodate specimens up to 2 ft cube and 200 lbs weight. Individually calibrated charts for computation of shock stresses are provided.—JAN Hardware Mfg. Co., Inc., 75 N. 11 St., Brooklyn 11, N. Y.

For more information circle 196 on inquiry card.

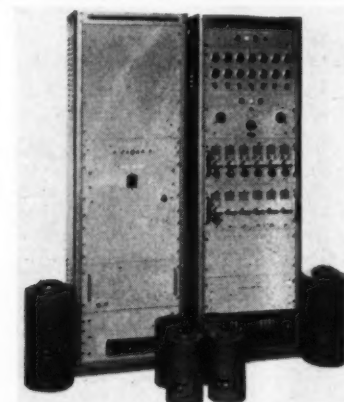
HIGH SPEED RECORDING PAPER

New Linagraph Direct Print paper for use in reflecting galvanometer measurements over a wide range of writing speeds provides an immediately visible record without chemical processing. Writing speeds approximating 25,000 ips using point-source mercury-arc lamps provide an invisible latent image later made visible by secondary low-intensity exposure. Writing speeds less than 40 ips require no secondary exposure.—Eastman Kodak Co., Graphic Reproduction Sales Div., 343 State St., Rochester 4, N. Y.

For more information circle 197 on inquiry card.

ATLAS MISSILE TESTER

Gilmore Six-Component thrust measuring system indicates and records (a) weight and thrust, (b) pitch moment, (c) yaw moment, (d)

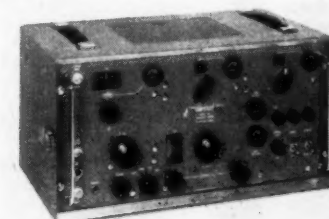


roll moment, (e) XX axis side load, and (f) YY axis side load, compensating for wind side load and interaction of side load with moments.—Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.

For more information circle 198 on inquiry card.

FREQ METER EXCEEDS NEW FCC REGS

Model FM-6 frequency meter designed to exceed the new FCC regulations soon to be made effective, measures and generates frequencies ac-



curate to 1 part in 1 million over the 20 to 1000 mc range. Dials reading directly, requiring no correction curves or graphs, maintain correct calibration by use of automatic frequency lock and visual beat meter, from built-in 1 mc frequency standard.—Gertsch Products, Inc., 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

For more information circle 199 on inquiry card.

APER

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ACCURATE FREQUENCY SENSOR

New 400-cycle expanded scale frequency meters combine a stable non-linear bridge network with an expanded scale meter linear to input

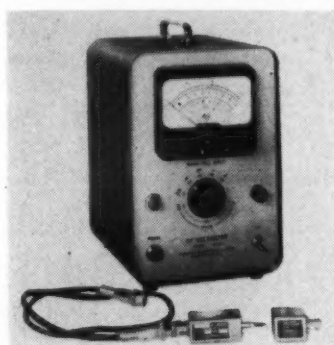


frequency at the 380-420 cps region, and readable within 0.25% accuracy. Can be furnished for any base frequency between 60 and 1000 cps.—Beckman/Helipot Corp., Newport Beach, Calif.

For more information circle 200 on inquiry card.

SENSITIVE RF VOLTMETER

New Model 91-CA RF Voltmeter provides high sensitivity for voltage measurements from 50 kc to 600 mc. Eight full-scale voltage ranges cover



from 1 mv to 3 v; also a 52-ohm rf probe and a 100:1 voltage divider are provided for measurements on coaxial systems.—Boonton Electronics Corp., 738 Speedwell Ave., Morris Plains, N. J.

For more information circle 201 on inquiry card.

INSULATION TEST SET

New portable insulation test set designated Model MD-1 can provide either non-destructive insulation re-

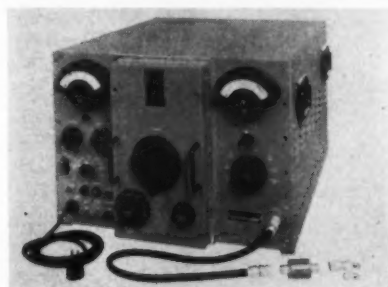


sistance test or destructive breakdown test to insulation specimens. Operates from a nominal 115 v, 60 cps, or 24 v dc supply.—Industrial Inst., Inc., 89 Commerce Rd., Cedar Grove, N. J.

For more information circle 202 on inquiry card.

HI-POWER SIGNAL GENERATOR

Model 30A, with output power of 10 to 15 v in the 40.7 to 400 mc

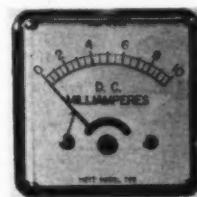


range, is useful in VHF-UHF antenna radiation-pattern measurements. Also useful in slotted-line, filter and other measurements where outputs in volts rather than millivolts are essential or desirable.—BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.

For more information circle 203 on inquiry card.

DC INDICATING METERS

New series of dc meters for original equipment or replacement in applications requiring 5% accuracy have shatter-proof, transparent plastic



faces 2 1/2" square which can be adapted for illumination or customized with inside color band. Available in dc sensitivities from 1 ma to 100 amp, and up to 300 v.—Hoyt Elec. Inst. Works, Inc., 42 Carleton St., Cambridge 42, Mass.

For more information circle 204 on inquiry card.

TRANSISTORIZED VSWR AMPLIFIER

New Model 441 Transistorized VSWR amplifier, with a sensitivity of 0.1 μ v at 200 ohms over the full scale is battery powered and free



from line voltage fluctuation errors. Attenuation range does not require switching when going from normal to expanded scale. Mercury batteries provide 600 hr operating life, two yr shelf life.—Narda Microwave Corp., 160 Herricks Rd., Mineola, L. I., N. Y.

For more information circle 205 on inquiry card.

SONIC-ULTRASONIC ANALYZER

New Model SS-500 wide-band spectrum analyzer provides instantaneous Fourier analysis of high speed vibration, noise, pulses and harmonics re-

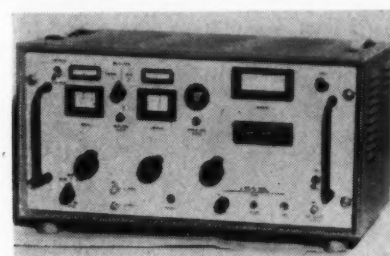


quired in design of jet engines, telemetering, microphonics and wind turbulence tests. Provides center frequencies to 500 kc; sweep widths 2kc to 200kc; full scale sensitivity 250 μ v to 250 v.—Proboscop Company, Inc., 8 Sagamore Hill Dr., Port Washington, N. Y.

For more information circle 206 on inquiry card.

VHF FREQUENCY METER

New Frequency Meter accurate to 0.0001% from 20 mc to 3,000 mc is capable of measuring and generating frequencies from 10 kc to 3,000 mc.

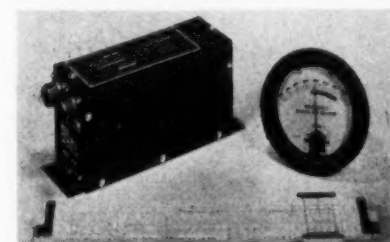


No calibration or temperature correction curves are required, making the meter particularly useful for mobile and military use. Full accuracy obtained after only 20 minutes warm-up.—Lavoie Labs., Inc., Matawan-Freehold Rd., Morganville, N. J.

For more information circle 207 on inquiry card.

PRECISION FREQUENCY METER

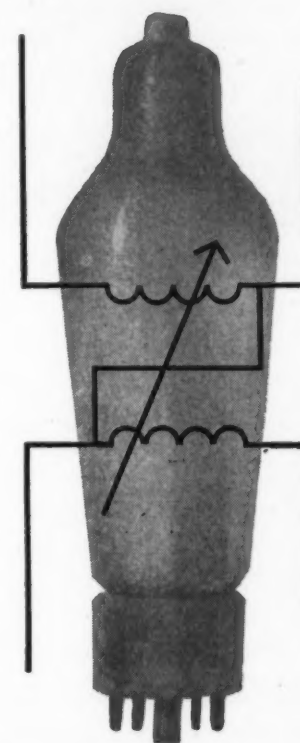
New transistorized frequency meter provides 0.05% accuracy at 400 cps by calibration of the discriminator



with an internal tuning fork. Accuracy of 0.1% is achieved at full scale, 397 to 403 cps. For use with motor generators and missile ground test units requiring close monitoring of airborne and missile power.—Varo Mfg. Co., Inc., 2201 Walnut St., Garland, Tex.

For more information circle 208 on inquiry card.

NO TUBE PROBLEM



You get . . .
Greater Reliability
From G-E Inductrol*
Voltage Regulators

Because G-E Inductrol voltage regulators are induction devices, there are no tubes to replace or maintain. This highly accurate $\pm 1\%$, reliable and economical voltage-control equipment has many operating advantages. It has "set it and forget it" tubeless controls which are unaffected by power factor, frequency or load changes. These engineered extras, plus drift-free controls, make Inductrol regulators one of the world's most reliable voltage regulators.

For more information write Section 425-15, General Electric Co., Schenectady, N. Y.

*Registered trademark of General Electric Company for Induction Voltage Regulators

Progress Is Our Most Important Product
GENERAL ELECTRIC

For more information circle 30 on inquiry card.

Miniature Precision Pots

New Type "E" miniature sealed wire-wound potentiometers of proved reliability, and meeting applicable Mil-Specs, provide sealing against humidity and salt-spray mechanical stops, anti-rotation pin, and choice of plain or split bushings. Standard resistances from 50 to 100,000 ohms are stocked at local distributors in three series: AP $\frac{1}{2}$ micro-miniature, RT $\frac{7}{8}$ miniature and AP 1- $\frac{1}{8}$ miniature. Standard resistances and approximate resolutions (Functional angle 300° for AP $\frac{1}{2}$, 310° for RT $\frac{7}{8}$ and AP 1- $\frac{1}{8}$ series):

RESOLUTION TABLE			
Resistance (Ohms)	AP $\frac{1}{2}$ Resolution (%)	RT $\frac{7}{8}$ -RTS $\frac{7}{8}$ Resolution (%)	AP 1- $\frac{1}{8}$ Resolution (%)
50	.71	.45	.36
100	.62	.42	.35
200	.50	.36	.28
500	.40	.30	.18
1K	.45	.18	.18
5K	.30	.16	.16
10K	.21	.13	.11
20K	.19	.096	.09
50K	.15	.08	.075
100K	.092	.07	.06

—(From 4-page catalog, Type E Miniature Precision Potentiometers, Waters Mfg. Inc., Wayland, Mass.)

For this literature circle 209 on inquiry card.

Video Detection Systems

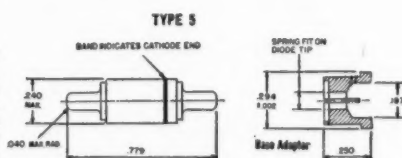
Simplified video receivers with inherent low-power requirements are especially popular in airborne beacon receiver applications. Video detection is also popular for broadband, "wide open" applications such as inter-

MICROWAVE VIDEO DETECTOR DIODES

FORWARD POLARITY	VIDEO DIODE TYPES ¹	REVERSE POLARITY	REVERSIBLE POLARITY ²	TEST FREQUENCY (MC)	POWER LEVEL (mW)	FIGURE OF MERIT (dBm)	MINIMUM SENSITIVITY (dBm)
IN32	IN32R	MA-408	MA-408R	2205	5.0	15	—
MA-408	MA-408R	MA-408A	MA-408AR	9000	1.0	130	—36
MA-408A	MA-408AR	MA-408B	MA-408BR	9000	1.0	160	—51
MA-408B	MA-408BR	MA-408C	MA-408CR	9000	1.0	220	—52

¹The IN32 and MA-408 series are interchangeable with IN21 and IN23 series mixer diodes but insure improved signal to noise video receiver performance.

²These reversible polarity cartridge types are electrically and mechanically identical to their fixed polarity counterparts and are directly interchangeable with the indicated fixed polarity types. See



Outline Type 5 for mechanical specifications. Reversible polarity diodes will normally be supplied with the spring-held base adaptor shown. An equivalent setscrew-

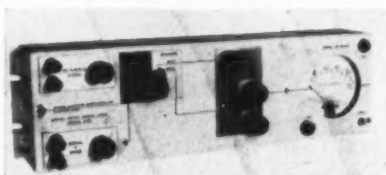
held adaptor is available and can be supplied on special order at a slight additional cost. ³Theoretical tangential sensitivity for a receiver bandwidth of 10 mc/s.

cept receivers, where the local oscillator tracking difficulties of the superhetrodyne present complex design problems. New diodes MA-408, 408-A and 408B series are particularly designed for reproducible results in video detector applications. (From 22-page Catalog 58S, Silicon Diodes for Microwave Receivers, Microwave Associates, Inc., Burlington, Mass.)

For this literature circle 210 on inquiry card.

SIGNAL-NOISE CORRELATOR

Signal-to-noise ratios can be measured at the outputs of receivers, amplifiers, magnetic tape systems, etc., without removing either the

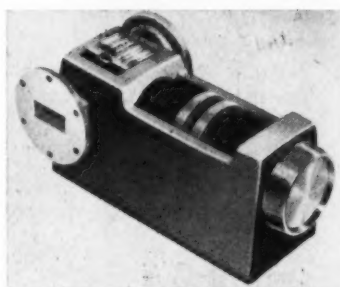


signal or noise; both being present at the same time in the output measured.—General Electronic Laboratories, Inc., 18 Ames St., Cambridge, Mass.

For more information circle 211 on inquiry card.

MICROWAVE FREQUENCY METERS

New types 532 through 538F1 reaction-coupling frequency meters each cover a full waveguide band in the frequency range from 3.95 to 40 kmc.



Continuous 100" long helical dial reads frequency directly to accuracy of 0.08% for most ranges. May be installed as permanent components in system or used as lab test instrument.—Polytechnic Research and Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.

For more information circle 212 on inquiry card.

POWER TRANSISTOR TEST

New electronic curve tracer, designated Dunn Model 341, is designed to permit observation of transistor anomalies, changes or deterioration, for checking tolerance and in matching or comparing transistors. It fur-



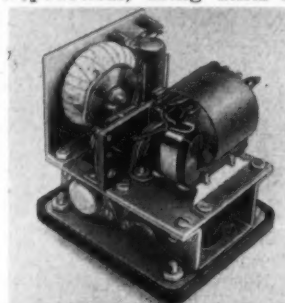
nishes collector currents up to 6 amp continuously or 15 amp intermittently and produces r_{12} , r_{22} and h_{12} families of curves on an auxiliary oscilloscope.—Dunn Engineering Assoc., Inc., 225 O'Brian Highway, Cambridge 41, Mass.

For more information circle 213 on inquiry card.

TUBES, TRANSISTORS POWER SUPPLIES

DC-AC STATIC INVERTERS

Mobile or emergency operation of 60 or 400 cps ac equipment in a wide range of voltages from battery power is now practical, using units from a

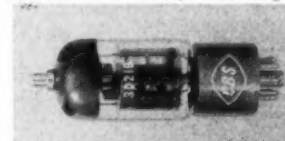


complete range of UAC transistorized static inverters. Light weight, compact size, and high efficiency, ability to operate from nominal storage battery inputs 6 to 64 v dc; and sinusoidal or square wave outputs each available in single or three-phase, are features of these reliable units.—UAC Div. Universal Transistor Products Corp., 17 Brooklyn Ave., Westbury, L. I., N. Y.

For more information circle 214 on inquiry card.

BEAM-POWER PULSE MODULATOR

New type USN-3D21B beam-power pulse modulator tube, said capable of

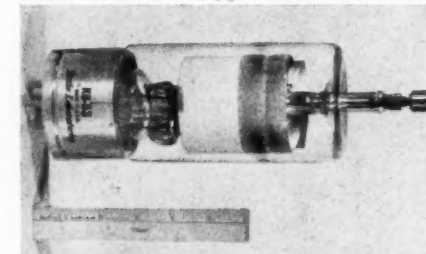


delivering 21 kw in 10 μ sec pulses, may also be used as high-voltage blocking oscillator, hard switch tube, deflection amplifier, and regulator or pass tube in high-voltage supplies.—CBS-Hytron, Parker St., Newburyport, Mass.

For more information circle 215 on inquiry card.

HYDROGEN-FILLED DIODE TUBES

New Kuthe series hydrogen-filled tubes used as clipper and shunt di-

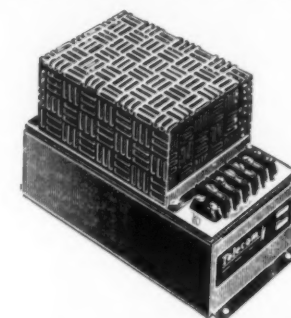


odes in radar modulator combine pivoting of 33 kv, peak current rating of 500 amp, and low anode voltage drop with small envelope size.—Components Div., International Tel. & Tel. Corp., P. O. Box 412, Clifton, N. J.

For more information circle 216 on inquiry card.

DC-DC POWER CONVERTER

New Model 2D11 transistorized plate supply converter for mobile use supplies two outputs: 500 v at 200 ma and 250 v at 100 ma from 12.6

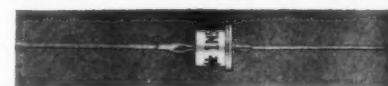


v dc (storage battery) input. No tubes, vibrators or moving parts; conversion efficiency is approximately 80%. Conversion frequency of approx 1000 cps facilitates filtering and transistorized circuit does not radiate electrical noise. Rated for continuous duty from -20° to 104° F.—Telecom, Inc., 1019 Admiral Blvd., Kansas City, Mo.

For more information circle 217 on inquiry card.

NEW JAN-TYPE SILICON DIODES

Three new JAN types of silicon power rectifiers IN538, IN540 and IN547 are being manufactured in quantity to Military specifications.

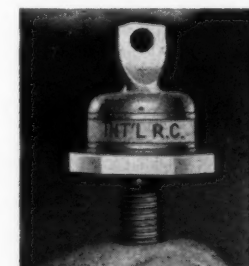


These units cover the range from 200-600 vpi, and from 750 ma dc at 50° C to 250 ma dc at 150° C. Operate at temperatures from -55° to 165° C and can be stored in ambients from -65° to 180° C.—General Instrument Corp., Automatic Mfg. Div., 65 Gouverneur St., Newark 4, N. J.

For more information circle 218 on inquiry card.

MINIATURE SILICON POWER DIODES

Peak inverse voltages to 500 v, and forward currents to 45 amps at junc-



tion temperatures of 200° C are operating parameters for new miniature silicon units. No soft solders or fluxes are used in hermetic sealing for increased reliability.—International Rectifier Corp., 1521 Grand Ave., El Segundo, Calif.

For more information circle 219 on inquiry card.

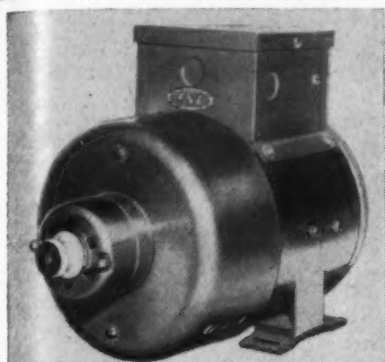
MILITARY AUTOMATION

RTER

storized
mobile use
at 200
from 12.6

3-KW DC-AC CONVERTER

Newest addition to the Kato line of dc-ac converters is the 3000-watt 60 cps unit pictured, designed for marine and other special applications



where more ac power is needed than is provided from standard converters. Models for various dc inputs are available. For loads greater than 3-kw, dc-ac motor generator sets in 60 and 400 cps models can be supplied. The present converter line extends from 100 to 3000 watts output with more than 50 dc input and ac output combinations available. The unit illustrated is equipped with a speed governor to maintain constant frequency regardless of load deviations.—Dept. 43E, Kato Eng. Co., Mankato, Minn. For more information circle 220 on inquiry card.

POWER FOR SMALL MISSILES

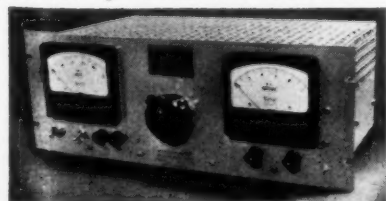
Models PS1008 and PS1009 transistorized power converters, 5.5" dia



by 4 1/4" long, provide 270 v at 22 ma, 150 v at 10 ma and 30 v at 15 ma from 16 v dc (PS1008) and 7 v dc (PS1009) inputs. Meet all missile shock and vibration specs, operate up to 85° C ambients.—Power Sources, Inc., Burlington, Mass. For more information circle 221 on inquiry card.

AC-DC TRANSISTORIZED SUPPLY

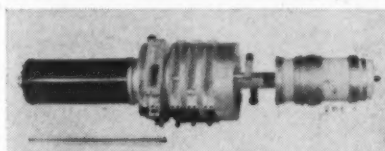
Four 32 v dc, 10 amp loads are provided by Model HY A1-32-10 at



output impedances less than 0.01 ohm from dc to 100,000 cps, with less than 0.5% regulation from 0 to full load and 0.5% for 105-125 v ac line variations.—Hyperion, Inc., 1447 Washington St., W. Newton, Mass. For more information circle 222 on inquiry card.

TROPO-SCATTER USES 10-KW CW KLYSTRON

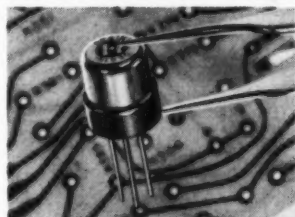
New external-cavity power-amplifier klystron, covering the 1700 to 2400 mc range and designated 4KM-50,000SG, is now in use in high-power



tropospheric scatter installations. It delivers a rated 10-kw CW power output with less than 1 watt drive at an efficiency of from 35 to 40%. Shaped-pulse and amplitude modulation as well as CW operation are made possible by the special Eimac modulating anode. Also featured is a new adjustable waveguide output-coupler permitting smooth optimum coupling over the entire tuning range.—Eitel-McCullough, Inc., San Bruno, Calif. For more information circle 223 on inquiry card.

SILICON ZENER ELEMENTS

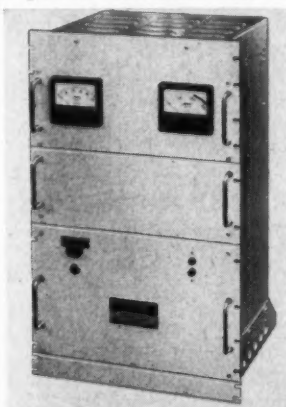
Two new silicon junction Zener reference elements are designed to



hold constant voltage levels in miniaturized printed circuit systems operating at 10 to 30 v dc.—Semiconductor Div., Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ill. For more information circle 224 on inquiry card.

SILICON POWER RECTIFIER

New line of automatically regulated silicon power rectifiers for missile



testing and general use from 30 to 1500 amp at voltages from 5 1/2 to 135 v dc. Stable magamp control circuit provides regulation within 0.5%, response within 0.1 sec, and ripple within 1% rms.—Christie Electric Corp., 3410 W. 67 St., Los Angeles 43, Calif. For more information circle 225 on inquiry card.

TRANSISTORIZED LABORATORY POWER SUPPLY

Rugged semiconductor circuit features voltage-regulated power source



with rapid recovery from transients and freedom from accidental short-circuit damage. Model HP 361 (illustrated) provides output current of 1.5 amp at any voltage from 0 to 36 v dc for transistor and medium-voltage vacuum tube circuits.—Deltron, Inc., 2905 N. Leithgow St., Philadelphia 33, Pa. For more information circle 226 on inquiry card.

X-BAND TUNABLE MAGNETRON

Type MA-6229 mechanically tunable pulsed type magnetron with integral magnet features high efficiency, tunability, ruggedness and light



weight (1.5 lb) for the 8900-9600 mc range. May be operated with good spectrum characteristics from 400 to 1000 watts, applying a pulse voltage of 4000 to 4500 v, peak anode current 0.5 to 1 amp and 5.0 v, 0.4 to 0.5 amp heater power. Nominal tuner torque rating is 20 oz-in.—Microwave Associates, Inc., Burlington, Mass. For more information circle 227 on inquiry card.

HYDROGEN THYRATRON TUBE

New Genalex Hydrogen thyatron for radar and other high-power pulse modulators features a replenisher



which generates hydrogen, barretter to keep gas pressure constant and control replenisher temperature, and internal baffle to keep barium deposits from grid. Four times conventional tube life is claimed.—Dept. K40, British Industries Corp., 80 Shore Rd., Port Washington, N. Y. For more information circle 228 on inquiry card.

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G-V
time delay
relay
does many jobs



other thermal
relays
cannot do...

- For military or industrial use
- Miniature and octal sizes
- Plug-in or flanged mounting
- Hermetically sealed
- Adjustable or non-adjustable
- Delay intervals 1/4 sec. to 5 minutes
- Unaffected by ambient temperatures—70° to 100°C

Our facilities assure prompt deliveries

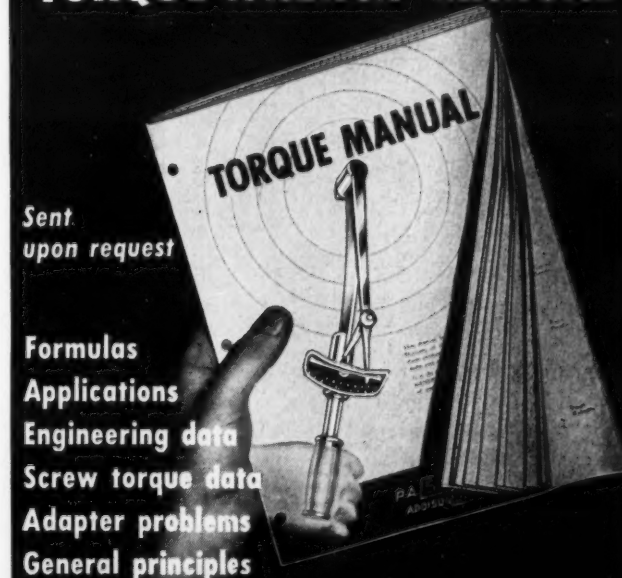
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G-V CONTROLS INC.
62 Hollywood Plaza
East Orange, N. J.

For more information circle 31 on inquiry card.

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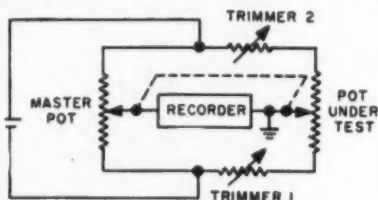
For more information circle 32 on inquiry card.

ATION

May-June, 1958

Linearity Testing of Potentiometers

The master potentiometer and the potentiometer under test are mechanically coupled and are phased so that they track when driven together. The trimmers are set for zero error at the end points, i.e. 0° and 360° in the case of a ten-turn unit. The potentiometers



eters are then rotated over their travel and a recording made of the slider voltage difference. With a suitably calibrated recorder gain the recording measures the relative linearity deviation of the two potentiometers. The master potentiometer is of high absolute linearity, preferably at least ten times the accuracy tolerance of the unit under test so that the error curve is essentially that of the unit under test.

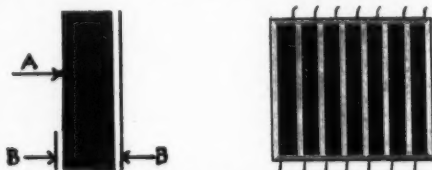
Trimmers are placed in series with either potentiometer as required to permit adjustment of trimmer 1 for zero recorder reading at zero rotation and trimmer 2 for zero recorder reading at full rotation.

(From 10-page catalog P-103, *Precision Potentiometers*, Analog Controls, Inc., 39 Roselle St., Mineola, N. Y.)

For this literature circle 231 on inquiry card.

Ruggedized Solar Cells Can Outlast Satellites

New type "SS" silicon P-N junction photoelectric cells are now being made in ruggedized form for use in space vehicles. This involves aluminum alloying



(LEFT). CROSS SECTION through single cell. (A) Energy collecting surface, (B) Contact strips. (Right) "Shingled" cell assembly.

of the thin metal strips and backing of each individual cell. Many of the miniscule cells are then assembled into "shingled" formats (see illustration). The alloying eliminates difficulties formerly encountered in the low-temperature soldering of connector strips.

The new solar photo-voltaic cell can turn eight per cent of the incident sunlight, calculated at 1400 watts per square meter, into electric power continuously for a period of 10,000 years. Capable of withstanding vibrations 10 through 60 cps, 100 G shocks for 0.003 sec in any direction, and ambient temperatures from -190° to 500°C, the new solar cell assemblies are already at work in the first Navy Vanguard satellite. Type "SS" silicon junction cells and groups are a development of the *Hoffman Electronics Corp.*, Semiconductor Div., 922 Pitner Ave., Evanston, Ill.

For more information circle 232 on inquiry card.

New Products—Cont.

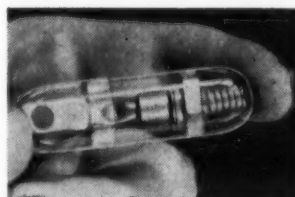
SELENIUM RECTIFIERS SUPPRESS ARCS

Selenium rectifiers specifically designed for use as arc suppressors prevent arcing during opening and closing of contacts, have negligible effect on circuit operation, are low in cost and easily mounted. Typical SP3 series, hermetically-sealed units are suitable for ac circuits drawing up to 600 ma at 150 v or dc currents up to 750 ma at 147 v. Phenolic housings and higher ratings are available.—*Bradley Laboratories, Inc.*, 168 Columbus Ave., New Haven 11, Conn.

For more information circle 233 on inquiry card.

KILOWATTS IN A CAPSULE

Miniature diffused-junction silicon power-rectifier rated at 20 amp dc at

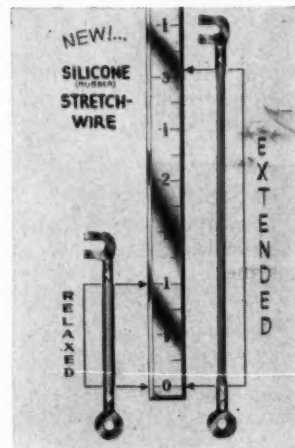


max peak inverse potentials up to 400 v is specifically designed for dc power supply and magnetic amplifier applications in ambients to 150° C. Four such units in full-wave bridge will drive a 10-hp 230-v dc motor.—*Fansteel Metallurgical Corp.*, North Chicago, Ill.

For more information circle 234 on inquiry card.

SILICONE STRETCHABLE CABLE

Silicone rubber incorporated in stretch cable ensures elastic properties are retained from -150° to 375° F. Dielectric strength is 550 v/mil,

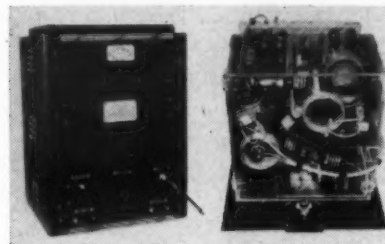


tensile strength is 1500 lbs/sq-in and it has a hardness rating of Shore A 55. Stretch cables can be easily extended 200% and retracted to their original relaxed length.—*Stretch Wire Corp.*, P.O. Box 893, New Rochelle, N. Y.

For more information circle 235 on inquiry card.

HIGH-VOLTAGE SUPPLY

New regulated dc power supply Model LAB-90 features continuously-variable output from 0 to 90-kv. Output current is 1 ma at 80-kv, 2 ma



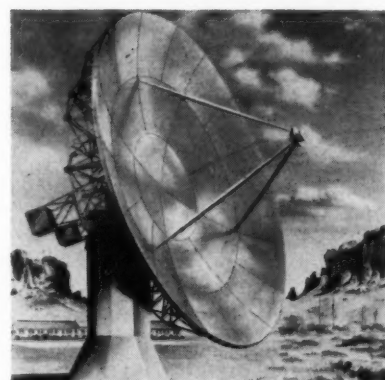
from 40 kv down, with voltage regulation better than 1% throughout the range. Available in either positive or negative polarity output.—*Spellman Television Co.*, 3029 Webster Ave., New York 67, N. Y.

For more information circle 236 on inquiry card.

RADIO, RADAR, TELEMETERING

SPACE TRACKING ANTENNA

New antenna system for use in radio astronomy and space-vehicle tracking, consists of reflector, R-F feed and supporting mount, tower, and servo control system. The azi-

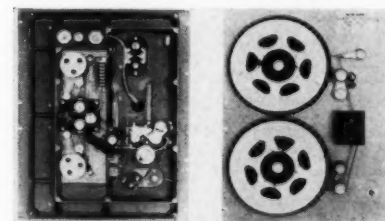


muth elevation (AZ-EL) mount, designed with a specifically oriented "Eddy-Current Clutch" servo control system, can duplicate the motions of an equatorial mount.—*General Bronze Corp.*, 711 Stewart Ave., Garden City, N. Y.

For more information circle 237 on inquiry card.

AIRBORNE DIGITAL TAPE RECORDER HAS 12-HR CAPACITY

New Model MR-100 magnetic recorder, originally for balloon use, re-



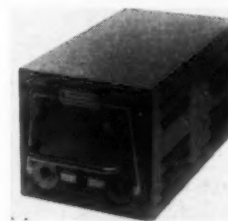
records 7-channels on 1/2" tape at 1"/sec, running 12 hours on only 1/4

amp at 28 v dc. Recorded data can be played into a standard IBM digital computer. One track may be used for timing pulses while data is recorded on the other six channels at densities up to 200 pulses/in. Maker offers engineering assistance in modifying basic recorder to accept analog and digital recording at any tape speed to meet frequency response requirements.—*Northam Electronics, Inc.*, 2420 N. Lake Ave., Altadena, Calif.

For more information circle 238 on inquiry card.

PREAMP FOR HIGH SPEED RECORDER

Feeble dc signals as low as 20 μ v produce full scale deflection of a high-speed 12" chart potentiometer in 1/4 sec or less when amplified by new

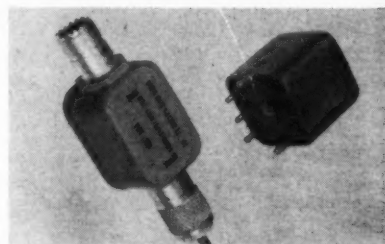


Honeywell Model 2HLA-7 preamplifier featuring isolated differential input, 20 cps frequency response, 1 μ v recorded noise and drift, and gains to 100,000. Applications include low level and differential thermocouple measurements, strain gage analysis, and photocell measurements.—*Minneapolis-Honeywell*, Boston Div., 1400 Soldiers Field Rd., Boston Mass.

For more information circle 239 on inquiry card.

WIDE BAND RF TRANSFORMERS

New type 1210 wide band transformer operating over the 0.1 to 100 mc range with minimum insertion loss has a 600:75 ohm impedance



ratio, either step-up or step-down. Uses include antenna matching, receiver and low-power transmitter coupling, etc., where excellent balance, low crosstalk and minimum capacitive coupling are desired.—*North Hills Electric Co., Inc.*, 402 Sagamore Ave., Mineola, N. Y.

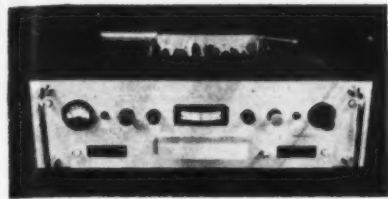
For more information circle 240 on inquiry card.

FM/FM SUBCARRIER DISCRIMINATOR

New high performance FM/FM discriminator, Model GFD-2, with associated bandpass and lowpass filters converts FM subcarriers into

MILITARY AUTOMATION

data can be intelligence signals at output levels for recording with penmotors or galvanometers. Accepts telemetry sub-carriers based on IRIG standards or

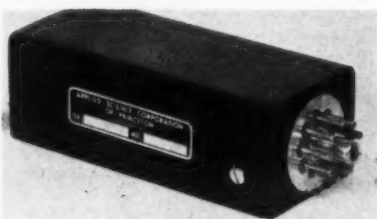


with $\pm 40\%$ deviation at 13.5 kc, 27 kc and 54 kc, using plug-in tuning units. Special plug-in selectors can be supplied for other frequencies and deviations.—Data-Control Systems, Inc., 39 Rose St., Danbury, Conn.

For more information circle 241 on inquiry card.

TELEMETERING OSCILLATOR

New ASCOP DKO-11 Keyer-Sub-carrier oscillator, designed to operate from negative triggering pulses from solid-state high-level commutators, in

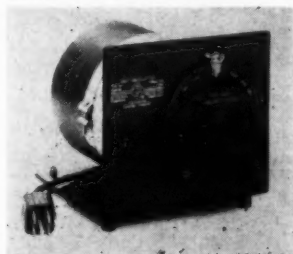


airborne PW/FM/FM telemetering systems conforming to applicable IRIG standards. Used with a suitable PW commutator, the DKO-11 permits multiplexing and PW encoding of a large number of data channels on a single 70 kc subcarrier oscillator frequency which can then be mixed with other subcarriers and applied to an RF carrier for radio transmission.—Applied Science Corp. of Princeton, P. O. Box 44, Princeton, N. J.

For more information circle 242 on inquiry card.

SINGLE OSCILLATOR COVERS 225-420 MC BANDS

New single G-R Type 1209-BL unit covering 160-600 mc replaces two butterfly-type unit oscillators previously required. As in other G-R unit

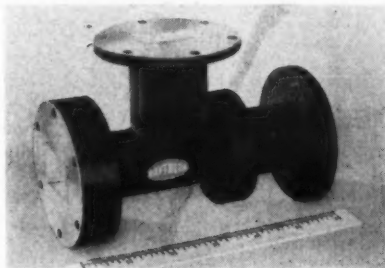


oscillators, a modified butterfly circuit with no sliding contacts is used with a direct-reading dial. Accuracy of 1% is guaranteed. Either standard or regulated plate voltage supplies and external plate modulation may be used with this unit.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

For more information circle 243 on inquiry card.

MINIATURE FERRITE CIRCULATOR

New C-band microwave ferrite circulator with permanent magnet

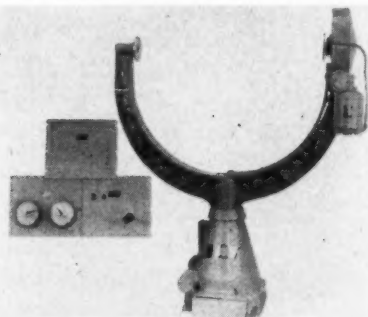


uses no external drive power; replaces conventional gas-tube duplexers. Minimum transmit-receive isolation is 20 db; max insertion loss is 5 db.—Raytheon Mfg. Co., Special Microwave Dev. Group, Waltham 54, Mass.

For more information circle 244 on inquiry card.

ANTENNA ROTATOR

VAR Variable Speed Antenna Rotator, will simultaneously tilt and rotate antennas weighing up to 200 lbs at variable speeds up to 30°/sec

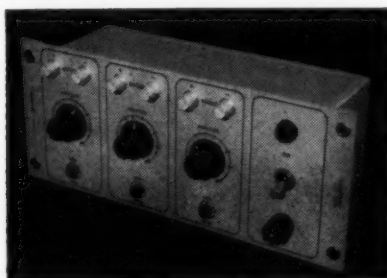


for fast tracking of missiles, etc. Remotely operated by variable-speed electric motors controlled by a "joystick", azimuth and elevation position indicators are provided in control panel.—Houston Fearless Corp. 11879 W. Olympic Blvd., Los Angeles 64, Calif.

For more information circle 245 on inquiry card.

HYBRID PULSE GENERATOR

Transistors and output tubes combine in Navcor's Model 1015A 0.1 μ sec pulse generator designed to supplement maker's 100 Series of transistor-



ized pulse programming equipment. Occupying rack space of two Navcor 2 1/4"-high modules, the unit has three independent sections each delivering negative and positive 0.1 μ sec 10-watt

pulses into separate 90-ohm BNC coaxial connectors. Each section can be triggered by any negative transient of 1 μ sec duration and 1 v amplitude, and the output pulses may be driven over long lengths of properly terminated 90-ohm coaxial cable. Type 6197 output-tube's plates and screens are supplied from a 210 v built-in supply, fused to protect against accidental removal of bias.—Navigation Computer Corp., 1621 Snyder Ave., Philadelphia 45, Pa.

For more information circle 246 on inquiry card.

TELEMETERING ANTENNA HAS 4-DEGREE BEAM

New 8 ft paraboloid weighing only 82 lbs provides a 4° pencil beam for



high gain. Dual speed drive in azimuth, single speed drive in elevation are provided. Conical scanning for automatic tracking, and horizontal, vertical and circular polarization are available.—Canoga Corp., 5955 Sepulveda Blvd., Van Nuys, Calif.

For more information circle 247 on inquiry card.

TRACKING AND SCATTER ANTENNAS HAVE HIGH SURVIVAL SPECS.

Latest "Sky-Chief" 60' and 90' parabolic reflectors are designed for use with General Bronze pedestal and servo system for radio telescopes or satellite and missile tracking antenna



systems. Designed for service on the "roof of the world" and in other severe environments, the "Sky-Chief 60" antenna, shown in final assembly, can withstand 150-mph wind loading or a combined load of 3" of ice plus a 120 mph wind; said to be the highest antenna survival specification yet designed. The new antennas can be installed in the field without adjustment, saving installation costs and employment of highly skilled technicians in remote areas.—General Bronze Corp., 711 Stewart Ave., Garden City, L. I., N. Y.

For more information circle 248 on inquiry card.

NETIC CO-NETIC

TAPE DATA PRESERVERS

Keep Data Clear, Distinct, Without Distortion

Permanently maintain original fidelity of recorded data on automation programming tapes, telemetering, broadcast, video and hi-fi tapes by diverting all damaging magnetic fields. Magnetic shielding qualities not affected if sturdy Netic Co-Netic containers are dropped or vibrated. Containers do not retain residual magnetism nor require periodic annealing.

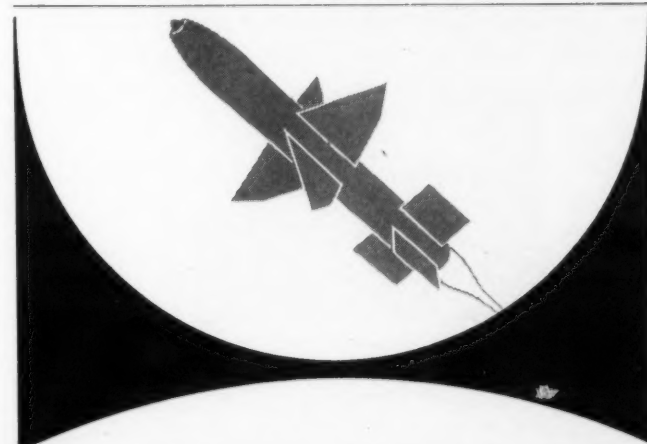


Successfully provide simultaneous high and low intensity shielding plus high and low frequency shielding from all damaging extraneous fields produced by generators, power supplies, transformers, magnetic tables on surface grinders, magnetic chucks, de-gaussers, soldering irons, motors, power lines, welding machines, solenoids, etc. around factories, laboratories, military installations, and radio and TV stations. Available in many convenient round or rectangular shapes. Write for sizes and prices today.

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For more information circle 34 on inquiry card.



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FREED 1110-AB INCREMENTAL INDUCTANCE BRIDGE

AND ACCESSORIES

Accurate inductance measurement with or without superimposed D.C., for all types of iron core components.

- INDUCTANCE — 1 Millihenry to 1000 Henry
- FREQUENCY — 20 to 10,000 Cycles
- ACCURACY — 1% to 1000 Cycle, 2% to 10KC
- CONDUCTANCE — 1 Micromho to 1 MHO
- "Q" — 0.5 to 100
- SUPERIMPOSED D.C. — Up to 1 Ampere
- DIRECT READING — For use by unskilled operators.

ACCESSORIES AVAILABLE:

- 1140-A Null Detector
- 1210-A Null Detector - V.T.V.M.
- 1170 D.C. Supply and 1180 A.C. Supply.

FREED VARIABLE TEST VOLTAGE MEGOHMMETER NO. 1620



The Freed Type 1620 Megohmmeter is a versatile insulation resistance measurement instrument with a continuously variable DC test potential from 50 to 1000 volts.

Components such as transformers, motors, printed circuits, cables and insulation material can be tested at their rated voltage and above, for safety factor.

- Resistance — 0.1 megohms to 4,000,000 megohms.
- Voltage — variable, 50 - 1000 volts.
- Accurate — plus or minus 5% on all ranges.
- Simple — for use by unskilled operators.
- Safe — high voltage relay controlled.
- Self contained — AC operated.

OTHER MEGOHMMETERS AVAILABLE

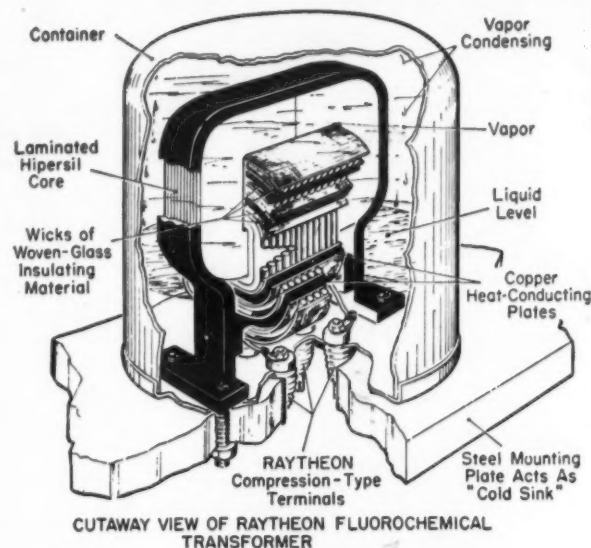
- Type 1620C MEGOHMMETER — a type 1620 with additional circuitry for testing capacitors.
- Type 1020B MEGOHMMETER — a 500 volt fixed test potential. Range 1 megohm to 2 million megohms.
- Type 2030 PORTABLE MEGOHMMETER — battery operated 500 volt test potential. Range 1 megohm to 10 million megohms.

Send for NEW 48 page transformer catalog. Also ask for complete laboratory test instrument catalog.

FREED TRANSFORMER CO., INC.
1793 WEIRFIELD ST., BROOKLYN (RIDGEWOOD) 27, N.Y.

For more information circle 33 on inquiry card.

Liquid Cooling Shrinks High-Voltage Transformers



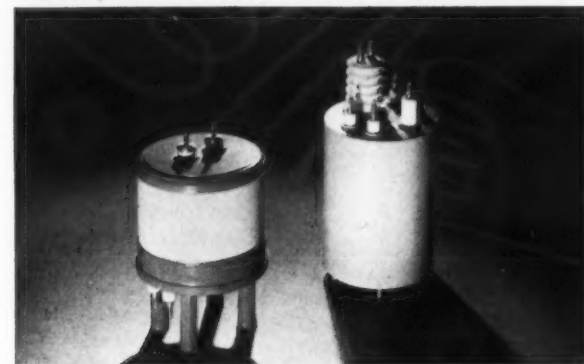
CUTAWAY VIEW OF RAYTHEON FLUORO-CHEMICAL TRANSFORMER

A Certificate of Excellence in Miniaturization, awarded by the Miniature Precision Bearings, Inc., was recently earned by a new line of high-voltage transformers, using a sealed-in liquid coolant which vaporizes on contact with the hot windings, then condenses on the inner surface of the transformer case. This adaptation of the familiar convection cooling principle is a development of the Raytheon Manufacturing Co., 100 River St., Waltham, Mass., which is being used in a number of missile and aircraft components.

The new evaporative coolant not only meets dielectric Mil-specs for corona at 11,000 volts, but enables the transformer to occupy a volume only one-half that originally specified as a possible minimum. The transformer windings are sealed in a steel case which is partially filled with a high-dielectric fluid fluorochemical (Fig. 1). Woven glass insulation acts as a wick to bring the fluid in contact with the hot winding. Here it boils away to vapor which escapes to the

FIG. 1. LATENT HEAT of vaporization and condensation and transfer of heat by convection are features of new miniature transformers.

FIG. 2. FLUORO-CHEMICAL cooling enables high capacity in one-third conventional volume.



inner surface of the case, where it is cooled and re-condensed. The "latent heat of vaporization" of the fluorochemical is the key to the efficiency of this method, which quickly cools the hottest spots and achieves a significant reduction of the temperature gradient between windings and case.

The new line of Fluorochemically cooled components includes a high-voltage transformer and a miniaturized magnetron filament transformer occupying only 1/3 the volume of a conventional ring-type transformer, but insulated for 25 kv and with only 10 $\mu\mu\text{f}$ capacitance from secondary to primary and ground. Both units are shown in Fig. 2. Another unit (not shown) contains all the magnetics for a medium-voltage, airborne power supply comprising four filter reactors and a nine-winding transformer. Occupying a volume less than 60 cu-in and weighing only 6 lbs, it is capable of continuous operation at 85°C at altitudes to 50,000 ft.

For more information circle 229 on inquiry card.

Reliability in Miniature Potentiometers

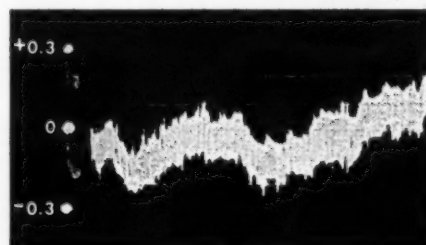
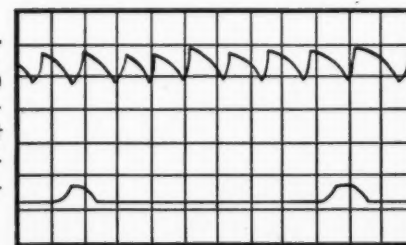


FIG. 1. LINEARITY error calibration test shows agreement of miniature pot within $\pm 0.3\%$ of standard pot linearity.

The problem of obtaining $\frac{1}{2}$ " size potentiometers with an accuracy of $\pm 0.3\%$ independent linearity with $\pm 2\%$ resistance tolerance requires extreme care in the making and assembly of each component part, with some operations being performed under binocular microscopes. From engineering through final quality control each mechanical and electrical characteristic must be tested and retested to assure guaranteed performance. As a sample of service to customers,

FIG. 2. OUTPUT of slowly-driven pot is differentiated, the height of each pip corresponds to voltage resolution.



Ace Electronics Associates, Inc., offers linearity and resolution tests of its precision potentiometers (Acepots) as shown in Figs. 1 and 2.

Fig. 1 is a photo of the cathode ray tube presentation of linearity error vs. rotation. The test circuit employed is a highly linear slide-wire circuit. To obtain the calibration marks at the beginning of the trace, precision calibrating resistors are connected in parallel to the potentiometer under test. Fig. 2 is a

resolution test performed by differentiating the voltage output of a slowly driven potentiometer. The height of each pip corresponds to the change in voltage, in other words to voltage resolution. The angular location of each pip is identifiable by angle reference marks in the upper trace. Some non-linear functions

FIG. 3. MINIA-TURE 500 Series precision pot superimposed on outline of standard precision pot.

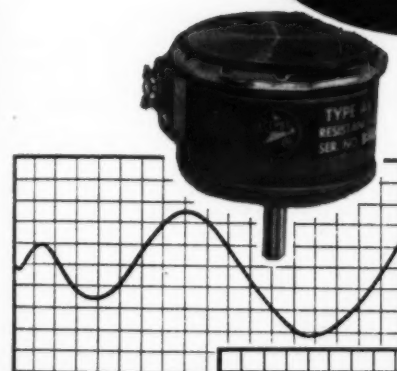
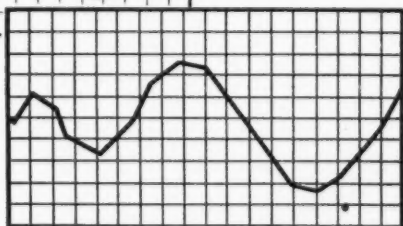


FIG. 4. STAND-ARD nonlinear Acepot has $\pm 0.25\%$ terminal conformity without padding—produces smooth output function curve.

FIG. 5. PADDED pot gives broken line function curve, also taps decrease reliability.



also can be produced in the Acepot $\frac{1}{2}$ " unit (Fig. 3), as demonstrated recently at the I.R.E. Show in New York City.

"Acepots" can be produced to 0.25% terminal conformity without padding resistors. A potentiometer without padding resistors produces a smooth output function curve (Fig. 4), within the limits of resolution, as opposed to a broken line function curve with the same limitation of resolution (Fig. 5). With the addition of padding resistors, reliability and accuracy are decreased since each padding adds a pair of critical tap-offs to the delicate wire windings. In addition, some servo systems are adversely affected by function slopes which do not conform to the desired curve.

Precision and reliability are assured with newly developed manufacturing techniques for miniaturized parts. Every potentiometer is completely sealed against sand, dust and foreign matter to avoid abrasive action between moving parts. All materials and metals are treated for maximum resistance to salt spray, corrosion and humidity, and meet MIL specifications for shock and vibration.

For more information circle 230 on inquiry card.

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For more information circle 36 on inquiry card.

TABLE 1. COMPARISON CHART SUMMARY OF MAJOR FACTORS

Tape Number and Description	Stability	Strength	High Temperature Performance	High Speed Performance	Long Wave Length Output	Short Wave Length Output	Recording Time
108 General Purpose	Best	Best	Good	Good	Good	Good	Normal
109 General Purpose	Good	Good	Good	Good	Good	Good	Normal
128 High Output	Best	Best	Very Good	Very Good	Best	Good	Normal
159 Extra Play	Best	Good	Good	Good	Good	Best	Extended

Magnetic Test Data Systems Cut

D. E. Denham and J. L. Kamiske

Minnesota Mining & Mfg. Co., St. Paul 6, Minn.

TABLE 2. MAGNETIC PROPERTIES OF "SCOTCH" BRAND MAGNETIC TAPE FOR INSTRUMENTATION USE

Tape Number	108	109	128	159
Description	General Purpose	General Purpose	Hi-Output	Extra Play
Intrinsic Coercivity	250	250	250	240
Retentivity	700	700	1100	1100
Remanence (Flux lines 1/4" tape)	0.6	0.6	1.2	0.6
Relative Output in db at 1% distortion**				
15 Mil Wave Length	0	0	+6	0
Relative Sensitivity in db**				
15 Mil Wave Length	0	0	+3.5	+1.5
1 Mil Wave Length	0	0	0	+3.5
Erasing Field	1000	1000	900	800
Uniformity at 15 mil Wave Length				
Within a Roll	±3%	±3%	±3%	±3%
Roll to Roll	±10%	±10%	±10%	±10%
Dropout Count***				
Errors/1 Roll	1	1	1	1

**At optimum bias for each tape type.

***Measure by recording 200 non-return pulses per inch on a 0.035" track. A reduction to less than 50% normal signal amplitude constitutes a signal error. Zero errors are measured by saturating the tape unidirectionally. Each spurious signal greater than 10% of normal signal amplitude constitutes a zero error. Errors per roll based on recording 7 tracks on rolls 1/2" x 2500'.



FIG. 1. AIRBORNE RECORDER used in recording flight-test data eliminates uncertainties of radio telemetering link. Lightweight Honeywell unit is used even in single-seater fighters.

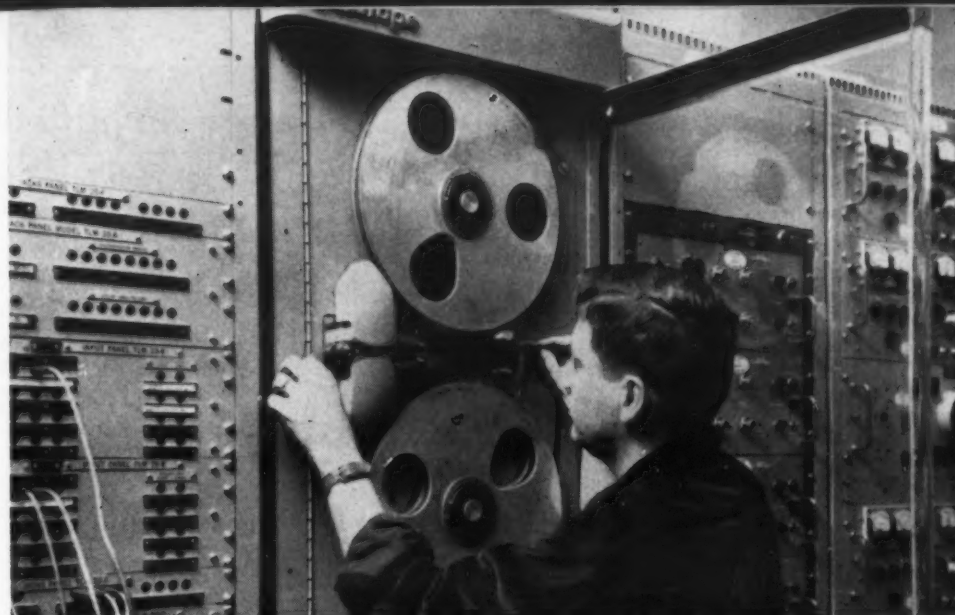


FIG. 2. GROUND-BASED TAPE RECORDER, Consolidated Electrodynamics Corp's Type-5-752, specifically developed for telemetering missile data can also be used in wind-tunnel, engine-test-stand and other high-speed data-processing applications.

ns Cut Costs, Speed Results in Aircraft and Missile Research

DATA collection and data processing, two costly and vital aspects of every aircraft and missile test program, are being expedited through use of magnetic tape systems using 1/5 the personnel, 15% of the time, and 20% of the cost of conventional data recording systems.

Either airborne (Fig. 1) or ground station recorders (Fig. 2) can be used to record flight test data. Although each method has specific advantages, both use the same basic pattern: Test variables are picked up by transducers, run through an electronic system, and are recorded on magnetic tape for automatic processing.

The test variables to be recorded, such as position, vibration, or temperature, must be translated into voltages by transducers or sensing devices. The nature and frequency of the variables not only determine the type of transducer but also the choice of recording system. Three types of recording—PM, FM subcarrier multiplex, and wide band FM—are generally in use.

Types of Recording

Pulse width modulation (PWM) recording is employed for low frequency variables and is suitable for data from dc to several cps. Position measurement, temperature, pressure, strain gauge and time-history presentations are typical applications for this method of recording. Commutation, permitting recording of several different quantities in sequence on one channel, is also characteristic of PWM recording.

The second type—*FM subcarrier multiplexing*—is employed for higher frequency response data, from dc to 2,100 cps. The third method—*standard wide deviation FM*—can be used when frequency response from dc to 10,000 cps is needed. In addition to these

three, *direct recording* with high frequency bias—typical in conventional sound recording—is also used to some extent. This is practical when frequencies up to 100 kilocycles are required but when response to dc is not necessary.

Because most test data fall in the response range from dc to several cps, the PWM system allows most economical use of magnetic tape for storage. As many as 86 channels of data may be crowded on one magnetic track. With high level transducer outputs (approx. 5 v) accuracies of about 1/2% may be attained. With low level transducers (approx. 15 mv) 2% accuracy is normal.

Data Processing

After a flight test, the roll of recorded tape must first be edited, a quick review to select those sections of tape containing the pertinent data. Speeds up to 8 times faster than recording speed can be used, a feature unique with magnetic tape, to edit a two-hour tape in as little as 15 minutes.

After editing, data can be digitized for calibration, tabulation, or computing. Digitization is accomplished electronically by counting devices whose output is normally recorded on another roll of magnetic tape which is then acceptable to standard electronic computers.

Magnetic Tape Requirements for Flight Test Recording

Basic components of magnetic tape construction which can be combined for optimum data recording are the binder system, the oxide and the backing material. In addition, uniformity and freedom from

“dropouts”, achieved only by careful manufacturing techniques, are highly critical factors in selecting a tape for flight test recording.

Binder systems must withstand tape speeds over 6, ips and operating ambients from -40° to 200° F and be designed to reduce oxide rub-off and head fouling at extreme temperatures, speeds and pressures.

New “high potency” magnetic oxides may be applied in standard thickness to produce about twice the output of standard oxides, as is done in the “Scotch” brand No. 128 tape for low frequency response data. It may also be used in thin coating with normal output but improved high frequency response. “Scotch” brand No. 159 employs this construction. Tables I and II compare characteristics of four instrumentation tapes.

Backing material stability under temperature and humidity change is of prime importance in flight test data recording. When many tracks are recorded side by side, data on each track must keep its relative position and no curling or stretching of the backing material can take place. Polyester backing is normally required in airborne materials, while acetate backing is successfully used for ground station recording where ambient conditions can be controlled.

Freedom from dropouts—losses or variations in signal—are controlled by careful attention to quality of backing material, thorough milling and mixing to obtain smooth oxide dispersion, and uniform coating uniformity. Through close quality control limits and careful processing, “Scotch” instrumentation quality tape averages less than one significant dropout in a mile of tape.

For more information on magnetic data recording circle 249 on inquiry card.

New Analyzer Cuts Isotopic Study Costs

New 100- and 200-channel memory core analyzers, designated RIDL Model 3300 and 3302 respectively, are designed to simplify the exacting and time-consuming analysis of radioactive isotopic samples required in isotopic identification and purity analysis, multiple tracer studies, and medical or physical experimentation (such as on scattering effects).

Up to four scintillation counters may be used simultaneously with the output of each detector routed into a separate sub-group, with 50 channels in each.

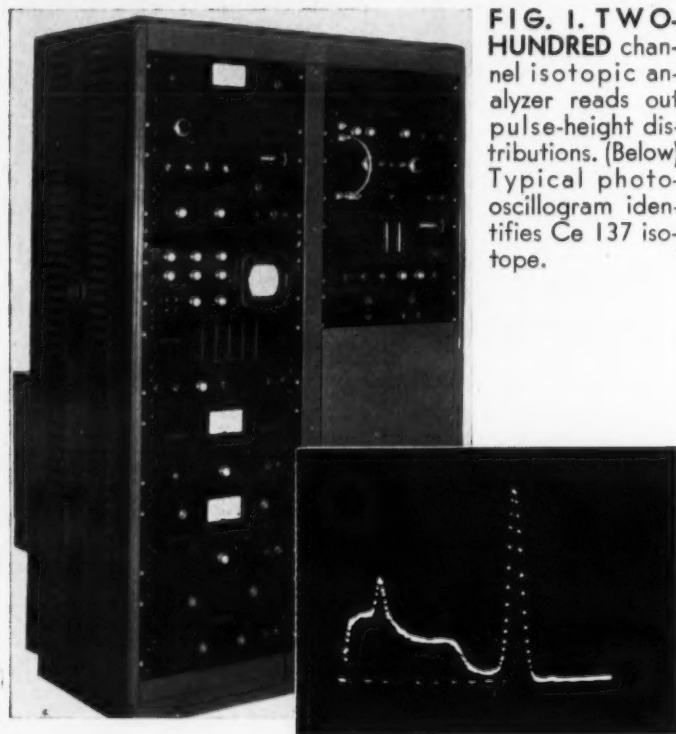


FIG. 1. TWO-HUNDRED channel isotopic analyzer reads out pulse-height distributions. (Below) Typical photo-oscillogram identifies Ce 137 isotope.

Analyzer circuits separate radiation pulses by energy level or direction and route the pulse-height distribution into appropriate 50 or 100-channel subgroups. Memory cores in each channel accumulate data for a preset time with a subsequent print-out cycle automatically starting with channel 0 and ending with channel 99, or channel 199 in the Model 3302 illustrated. A data photo-oscillogram of a typical Ce137 spectrum is also shown.

Several unusual applications are possible. For example, a sample changer may be programmed to change samples during each print-out, or successive short half-life readings may be taken automatically at fixed intervals. A complete print cycle can be taken every 25 seconds per hundred channels.

The amplifiers feature linearity better than 0.5%; with input counting rates greater than 10^6 cpm. Visual data presentation is by cathode ray tube with print-out to decimal printer or pen recorder. Background counts may be subtracted automatically. The RIDL Memory Core Analyzers are a development of the Radiation Instrument Development Laboratory Inc., 5737 Halsted St., Chicago 21, Ill.

For more information circle 250 on inquiry card.

New Products—Cont.

ADJUSTABLE FLANGE FEED

Polarization of center-fed, 7000 mc, parabolic antennas can be adjusted

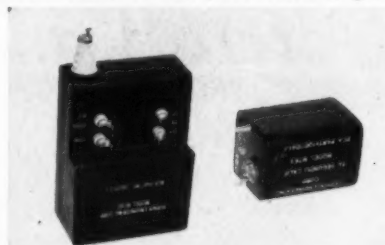


thru 360° using new mounting flange which is insertable from rear, fits standard GED feed-mounting bolts and can be adjusted after installation without removing nuts or bolts. —Gabriel Electronics Div., Needham, Hts., Mass.

For more information circle 251 on inquiry card.

ALL-WEATHER AIR-RADAR POWER UNITS

Model M763 Pulse generator (left) operates from a 13.8 v 400 cps input to provide a pulse of 320 v peak with a rise time of 0.9 μ sec with a pulse

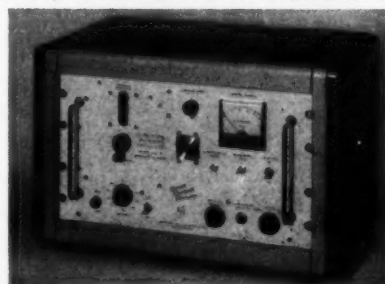


width of 4.8 μ sec. Rated for continuous operation at 16,000' in -40° to 100°C in 3"x2"x2" dimensions; HV dc power supply (right) provides 100 μ amp at 8 kv from 115 v 400 cps line with 5% no-load to full-load regulation. —Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

For more information circle 252 on inquiry card.

STABLE MICROWAVE OSCILLATORS

New Series 814 high-power, ultra-stable and tunable microwave oscillators spanning the range from 2500 to 17,500 mc are now available for

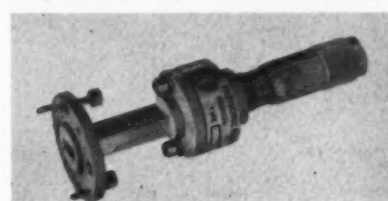


test or system applications requiring 20 mw to 1.5 watt outputs. Tuning is accomplished by setting the wave-meter dial to the desired frequency. A built-in stability circuit then locks the oscillator to the reference cavity. Short-term frequency stability averages 0.05 ppm. —Laboratory for Electronics, Inc., 75 Pitts St., Boston, Mass.

For more information circle 253 on inquiry card.

SLIDING SHORT TERMINATION

New PRD waveguide terminating impedance consists of a non-contacting coaxial-filter type short-circuiting plunger moved by a micrometer drive

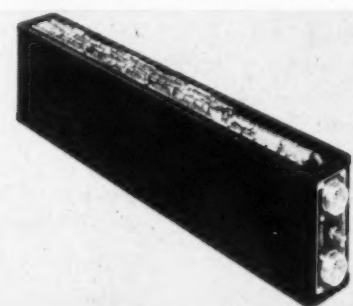


in a section of waveguide. Is used with slotted section to provide a variable short-circuit reference point or, in conjunction with a tee section, as a variable reactance or tuning for crystal or bolometer mounts. Available in five different flange types to cover the 12.4 to 75 kmc range. —Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.

For more information circle 254 on inquiry card.

SUBMIN TRANSISTORIZED MULTIPLEXER

New airborne subminiature electronic minimultiplexers, using solid-state and ferritic elements in modular construction, provide 12, 16, 20,

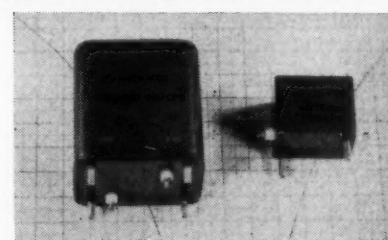


32 and 40 channel units. A 12-channel unit will operate with a maximum frame sampling rate of 1660 fps. A 40-channel unit operates up to 500 fps. Units are bidirectional and may be used for commutation or decommutation. Packaged modules meet applicable Mil-specs. —Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass.

For more information circle 255 on inquiry card.

NARROW PASSBAND FILTERS

High selectivity and stability are combined in the new subminiature Type 2E2SM6 passband filters in the



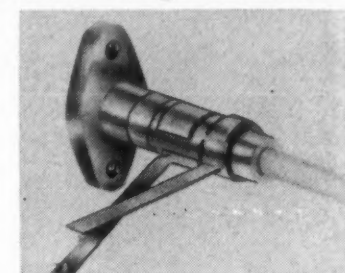
175-300 kc range, claimed to be the smallest filters offering such steep rejection slopes. Available in band-

widths from 20 cps to over 1 kc, they can be made in a shape factor (60/6 db) of 3.5 to 1. Drift is less than 10 cps over the temperature range of 0° to 75° C. The new unit, shown on the right, is designed for use in communications, telemetering and radar information devices. —Bulova Watch Co., Electronics Div., P-1015, Woodside 77, N. Y.

For more information circle 256 on inquiry card.

SEALED MINIATURE TRIMMERS

Completely sealed miniature piston capacitors which exclude moisture and protect against corona and voltage breakdown at high altitudes are des-

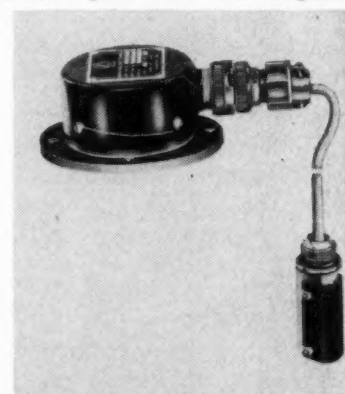


igned as Sealcaps. Available in panel-mount and printed-circuit mounting types, adjustment may be made by a standard Allen wrench. Units are furnished unpotted as shown or encapsulated with the outer electrode band imbedded and a Teflon insulated lead provided. —JFD Electronics Corp., 6101 16 Ave., Brooklyn 4, N. Y.

For more information circle 257 on inquiry card.

OPTICAL LIQUID LEVEL INDICATOR

New Optical Level Indicator contains no moving parts or relays but delivers up to 10 amps to indicate or control liquid level. Is designed for



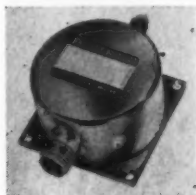
use with water-alcohol mixtures, jet and hydrocarbon fuels, hydraulic and lube oils, etc., regardless of opacity, if compatible with stainless steel probe housing. Operates on principle of total internal reflection, is claimed to be unaffected by acceleration, shock, altitude or foam and to distinguish between airflow and fluid flow when installed in a line. Meets applicable Mil-specs. —Revere Corp. of America, Wallingford, Conn.

For more information circle 258 on inquiry card.

MILITARY AUTOMATION

PRESSURE SENSOR IS VIBRATION PROOF

Extremely low vibration and temperature errors are claimed for a new miniature absolute pressure

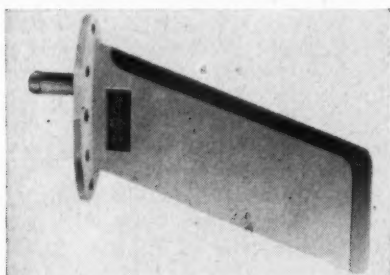


transducer designated Bourns Model 470. Well suited for airborne computers and telemetering, and sealed against dust, explosion and atmospheric exposure, it is available in standard pressure ranges from 0-5 to 0-100 psia, and in resistance values of 2, 5, and 10 K.—Bourns Labs., Inc., P. O. Box 2112, Riverside, Calif.

For more information circle 259 on inquiry card.

SUPERSONIC ANTENNA CUTS JET DRAG

New Type DM C7-2 antenna for transonic aircraft is a direct replacement for the AT-256/ARC antenna, used with communications and data

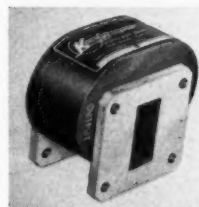


link equipment. At mach 0.9 and 25,000 ft. drag is reduced over 80%. Meets MIL-T-5422C specs, installed weight is 20 oz and VSWR is less than 2.5 over the 225-400 mc band.—Dorne & Margolin, Inc., 29 New York Ave., Westbury, L. I., N. Y.

For more information circle 260 on inquiry card.

LO-POWER X-BAND ISOLATOR

New Model W668-1A-2-0 Transverse Field Isolator uses built-in permanent magnet transverse field



and ferrite sections to provide 10 db isolation in the 8.5 to 9.6 kmc range with insertion loss of only 0.4 db, max VSWR of 1.10. Peak power of 300 kw contrasts with small dimensions of 1.4" x 2.3" x 2.6" wide.—Kearfott Co., Microwave Div., 14844 Oxnard St., Van Nuys, Calif.

For more information circle 261 on inquiry card.



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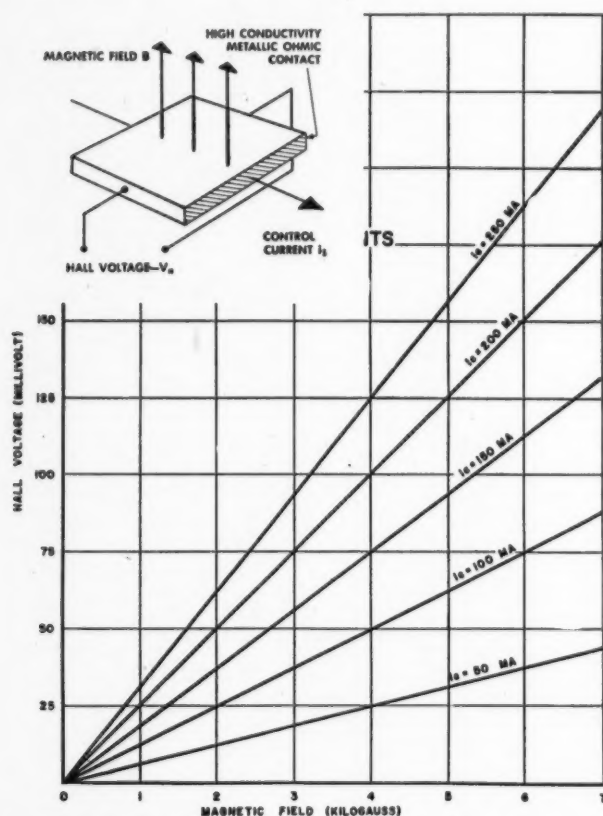
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Hall Effect Now A Rugged Instrumentation Principle

The Hall effect, discovered first in 1879 but relatively unused because of the low output of available sensors, has been made more usable by Westinghouse Electric Corporation scientists who utilize indium antimonide and indium arsenide as active elements. The Hall generator is an analog multiplying device that provides a voltage output proportional to the product of (a) the current passing through it, and (b) the magnetic field perpendicular to it (Fig. 1). In



INSET SHOWS principle of Hall Effect. Magnetic field at right angles to control current through Hall Effect element produces a voltage proportional to $B \times I_c$. Curves show output for different values of I_c .

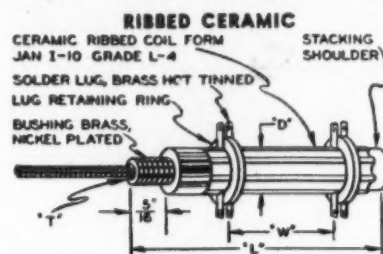
the Westinghouse device, output voltages of $\frac{1}{2}$ v are easily obtained in a magnetic field of 5 kilogauss with control currents of 500 ma (Fig. 2). Its output impedance can be adjusted from 0.01 to 20 ohms, and its maximum frequency response ranges from 10^7 to 10^8 cps.

This new sensing element, which physically can approach the dimensions of a large pin-head, can be used in exploring magnetic fields in nuclear research magnets, in a new family of computer elements, in simple current and voltage metering devices, in a greatly simplified wattmeter, in phase angle measurements, and in micro-wave field vector measurements. Its inventors state they are ready, willing and able to discuss possible applications and developments using this versatile new sensing and computing element.

For more information circle 262 on inquiry card.

SLUG-TUNED COIL FORMS

Silicone-impregnated ceramic forms are ribbed to permit leads to be brought under windings to lugs.

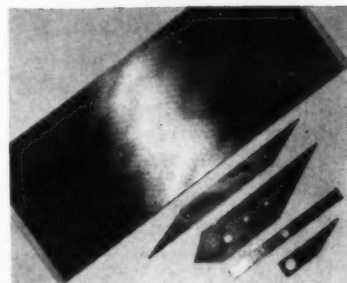


Available with standard or retractable type bushing which allows core to enter bushing, giving more effective winding area. Design allows forms to be stacked or bushings added to each end for double-tuned coils.—Waters Mfg., Inc., Wayland, Mass.

For more information circle 263 on inquiry card.

ULTRA STABLE RESISTANCE CARD

New microwave attenuator material features fibreglass plastic base with metallic deposit 50 millionths of an inch thick. Standard sizes are 5"



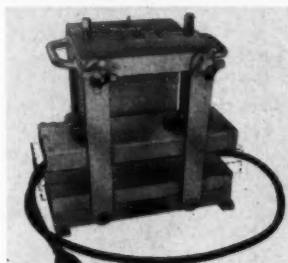
x 12" and 0.025", 0.032", and 0.062" thick. Stock resistance range from 50 to 500 ohms per square. No special machining techniques are required.—Filmohm Corp., 48 W. 25 St., New York 10, N. Y.

For more information circle 264 on inquiry card.

TOOLS & MATERIALS

ELECTRIC CABLE VULCANIZER

New molding press for reinsulating and re-jacketing natural rubber, syn-

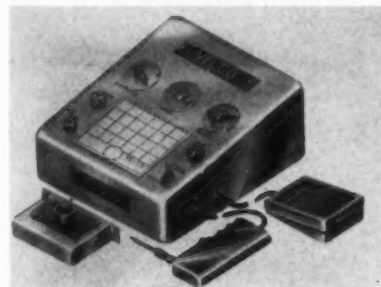


thetic rubber and thermoplastic cables can be used on Y and T splices in production and maintenance operations. Also seals cable-ends of those cable types exposed to weather on mothballed ships, equipment.—Dept. A-31, Elec. Prod. Div., Joy Mfg. Co., 1201 Mackland Ave., St. Louis 10, Mo.

For more information circle 265 on inquiry card.

PRODUCTION SOLDERING MACHINE

New Velco resistance contact soldering machine for assembly line soldering of miniature multi-contact connectors, etc., has temperature and



time control of solder heat, applies soldering current to single contacts in any sequence selected by the operator and controlled by a foot switch. Panel dial indicates contact being soldered.—Virginia Electronics Co., Inc., River Rd. and B. & O. R. R., Washington 16, D. C.

For more information circle 266 on inquiry card.

HI-TEMP MAGNET WIRE

Two new high-temperature insulations for magnet wire, on either copper or metals having higher temperature characteristics, are (a) refrac-

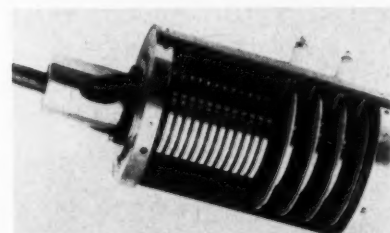


tory type rated to 700°F continuous, 800°F intermittent, and (b) ceramic type rated to 1000° F continuous. Illustration shows prototype magnet with ceramic wire operating in 1000° F furnace.—Secon Metals Corp., 7 Intervale St., White Plains, N. Y.

For more information circle 267 on inquiry card.

CENTRIFUGE SLIPRINGS

New slip ring assembly has three circuits capable of operating at 10 kv dc continuous and tested at 20,000 v. Instrumentation circuits are un-



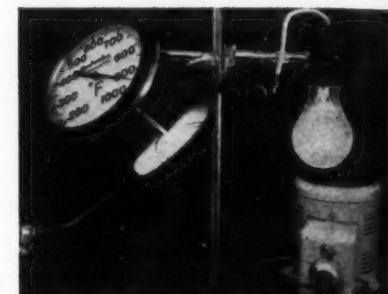
affected by adjacent high voltage circuits and noise is minimized by the use of precious metals. Dual brushes on each ring, tuned to different res-

onant frequencies, provide uninterrupted circuits during severe shocks and vibration. Rated at 350° F continuous, ball bearing mounts and sealed construction ensure life of 10 to 15 million noise-free revolutions at 6,000 rpm.—Slip Ring Co. of America, 3612 W. Jefferson Blvd., Los Angeles, 16, Calif.

For more information circle 268 on inquiry card.

MAGNET WIRE OPERATES AT 1000° F

New Ceramacite insulation, developed by the Consolidated Electro-dynamics Corp., of Pasadena, Calif., is now being applied by a wire company



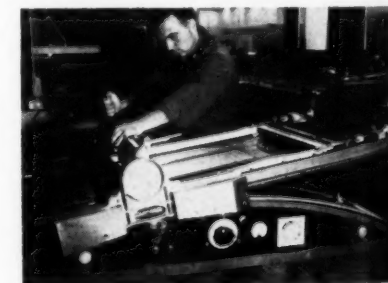
in coating AWG sizes 20 to 30 which will be marketed under the trade name of "Ceramtemp."

Nickel-clad copper conductors with a single thickness of the new inorganic insulation is shown here supplying full voltage to an incandescent lamp through the flame of a blowtorch. The new wire is expected to have an important impact in the design of new, highly reliable devices for high-temperature environments.—Hitemp Wires, Inc., Dept 1023, 1200 Shames Dr., Westbury, N. Y.

For more information circle 269 on inquiry card.

DRY SCREEN PROCESS SPEEDS CIRCUIT BOARD PRINTING

Quick-drying resists are applied to printed circuit boards being fabricated for SAGE computers in the IBM plant at Kingston, N. Y. The



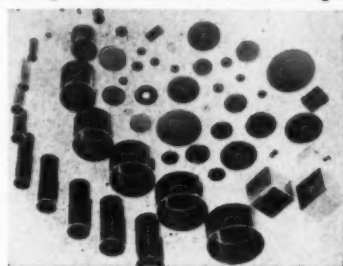
resist dries as soon as it comes in contact with the copperclad panel. The operator immediately flips the piece over and prints the second side, instantly ready for plating. Equipment and materials for rapid printing of circuit panels were developed by the Dry Screen Process Co.—Dry Screen Process Co., 1016 Madison Ave., Pittsburgh 22, Pa.

For more information circle 270 on inquiry card.

MILITARY AUTOMATION

EPOXY SHELLS CUSTOM-MOLDED

Compression-molded epoxy shells designed to customer's specifications are available for encapsulation of odd shapes and sizes without expense

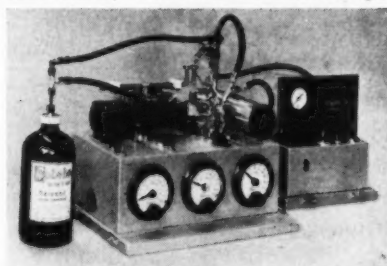


of temporary molds, release agents, and patching. Component is inserted in shell and epoxy compound added to complete encapsulation resistant to humidity, temperature changes, and solvents.—*Epoxy Products, Inc., 137 Coit St., Irvington 11, N. J.*

For more information circle 271 on inquiry card.

PRECISION PARTS CLEANER

New portable parts cleaner, Model 1-2BC-2S-S, delivers measured jets



of solvent and heated, filtered air against parts to be cleaned in alternate "spray" and "dry" periods until cleaning cycle is completed. Provides uniformity of cleaning and control of solvent costs.—*Cobehn, Inc., 126 Passiac Ave., Caldwell, N. J.*

For more information circle 272 on inquiry card.

DEMAGNETIZER AIDS PARTS CLEANING

New "drop thru" tubular demagnetizer with 6" throat demagnetizes production parts before cleaning or

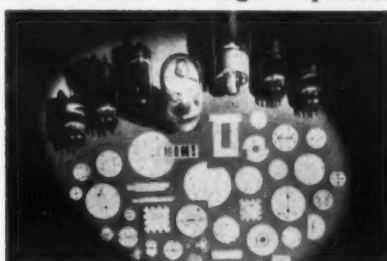


assembly. Tapered magnetic field avoids hang-up of parts in the concentrated field area. Unit is available in various lengths, kva and duty ratings for individual requirements.—*R. B. Annis Co., 1101 N. Delaware St., Indianapolis 2, Ind.*

For more information circle 273 on inquiry card.

ULTRA-THIN CERAMICS AID HIGH-TEMP ELECTRONICS

New AlSiMag Alumina vitrified parts with thicknesses as low as 0.005" enable new high-temperature

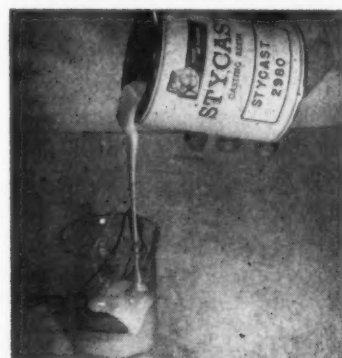


tubes to reach higher operating temperatures. Also used as micro-wave windows, in high-temp relays, transformers, fuses, and tinkertoys for high temperature amplifiers.—*American Lava Corp., Cherokee Blvd. & Mfgs. Rd., Chattanooga 5, Tenn.*

For more information circle 274 on inquiry card.

ONE-PART EPOXY RESIN

New fire-retardant, epoxide casting resin, designated Stycast 2980, is used

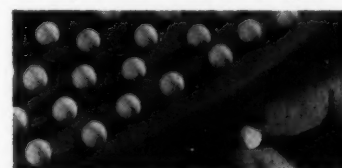


without addition of curing agent. Cures at moderate temperatures. Cured embedments can be used from -70° to 400° F, with insulation resistance above 10¹¹ ohm-cm at 400° F.—*Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.*

For more information circle 275 on inquiry card.

HEAT-RESISTANT GLASS BEARINGS

New precision bearing balls made of Corning Glass Co.'s Pyroceram have tensile strength comparable to cast iron; remain hard at 2,200° F;

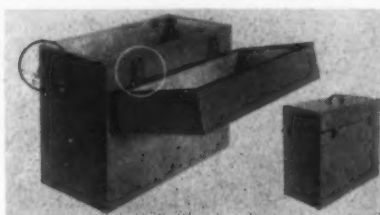


are not deformed by temperatures that warp steel or melt copper; are impervious to moisture, acids or electrical arcs. Pyroceram is as light as aluminum, and can be lapped to a high finish.—*The Hartford Steel Ball Co., Inc., 14 Jefferson Ave., W. Hartford 6, Conn.*

For more information circle 276 on inquiry card.

PRESSURE SEAL FASTENER

New Hinge-Lock, for instrument cases and pressure-tight shipping

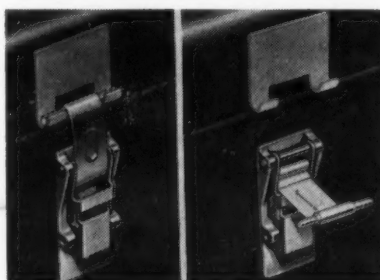


cases, insures pressure-tight seal where gasketing is used. Available in No. 2, medium-duty and No. 3, light-duty sizes.—*Simmons Fastener Corp., N. Broadway, Albany 1, N. Y.*

For more information circle 277 on inquiry card.

MINIMUM CLEARANCE TENSION LATCH

Compact lightweight Model 30L Toggle tension latch requires only 1/8"



envelope for engagement and takeup, permitting almost face-to-face storage of airborne equipment boxes and similar closures. Has an ultimate strength of 150 lbs; can be safety-wired.—*Camloc Fastener Corp., 106 Spring Valley Rd., Paramus, N. J.*

For more information circle 278 on inquiry card.

CABLE JACKET ZIPS ON

One man working alone does the work of two when new missile cable "Zipertubing" jacket is installed. Former jacket tubings required tedious pulling by two men. New zipper jacket also provides accessibility in changing wiring during research and development; sealer permanently seals jacket when need for changes is past. Many jacketing materials are available.—*The Zipertubing Co., 752 S. San Pedro St., Los Angeles 14, Calif.*

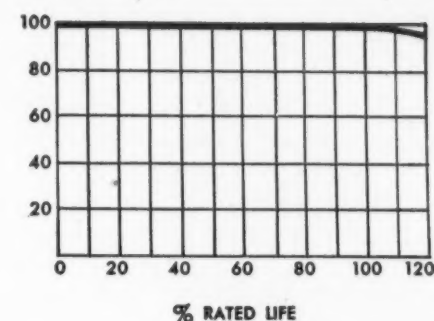
For more information circle 279 on inquiry card.

RESISTIVE INK BASE STOCK

New element base stock developed for resistive ink type volume controls, small resistors, etc., designated Di-electro XXXP-30 is a paper base phenolic with low moisture absorption (1%/24 hrs) and high resistance to blistering. The stock can be worked as easily as other element base stocks and has affinity for resistive ink coatings.—*Continental-Diamond Fibre Corp., Newark, Del.*

For more information circle 280 on inquiry card.

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For more information circle 37 on inquiry card.

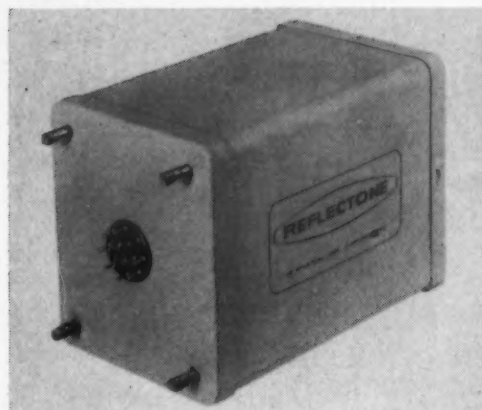


FIG. 1. REFLECTONE Type III magnetic servo amplifier.

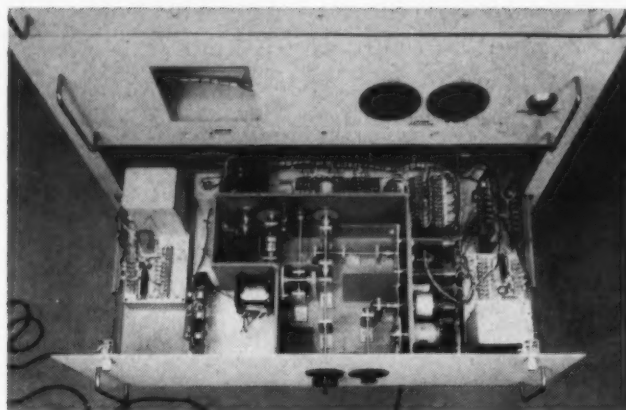


FIG. 2. TWO TYPE III magnetic servo amplifiers in computer drawer generate inputs to large-face classroom instruments.

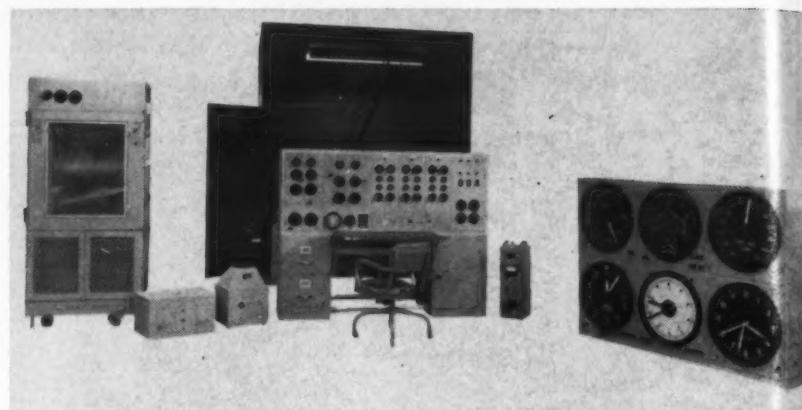


FIG. 3. COMPONENTS of the 1A19 Celestial Trainer can be set up in an available room. Planetarium-type facilities are not needed.

Mag-Amp Heart of Navy's Celestial Navigational Trainer

The Reflectone Type III Magnetic Servo Amplifier (Fig. 1), capable of driving a wide variety of standard two-phase 10-watt servo motors, has recently been selected for a number of military applications in which reliability is the paramount factor. Designed to operate from single- or double-speed synchro control transformers or from bridge networks, the half-wave reversible-output amplifier features rugged, encapsulated construction. The entire unit, including clamping diodes, is contained in a standard MIL type KA can (3-15/16" x 3-3/8" x 5-1/4") with all connections made to a hermetically-sealed header. These include input, output, stick-off voltage and feedback windings for gain control and servo stabilization.

Twenty Type III amplifiers are used in the recently-announced Reflectone 1A19 Celestial Navigation Trainer developed in conjunction with the U. S. Naval Special Devices Center, Port Washington, N. Y. They displace about 100 vacuum tubes, resulting in a tremendous increase in reliability. In another large Reflectone trainer the use of 120 magnetic amplifiers will

eliminate about 500 vacuum tubes.

Navigational and operational trainers free actual aircraft and their crews from long expensive training flights, saving thousands of dollars per training hour. The first 1A19 Trainer delivered to the Navy was air-lifted to Hawaii to speed its use in the training of navigators. The trainers are also expensive and necessarily specialized devices on which closely-scheduled training of hundreds of pilots and navigators depend. Down-time cannot be tolerated and only the most trouble-free components are used. Wherever vacuum tubes cannot be replaced by more reliable devices they are operated conservatively to ensure trouble-free uninterrupted performance.

Two Type III magnetic servo amplifiers are shown in one of the computer drawers of the 1A19 Trainer (Fig. 2) with other associated synchro elements which generate the inputs to large-face instruments (Fig. 3) designed to mount on the classroom wall. These inputs also feed into a simulated periscopic sextant located in the observation booth. When using a periscopic

sextant, the navigator inserts on its dials the assumed position of the navigational star which is to be observed, mounts the sextant and observes the star to refine his positional information. This procedure is followed in the 1A19 Trainer using a collimated light positioned by inputs from the computer to simulate the navigational star. Relative motions of the stars, earth and aircraft are simulated to accuracies comparable with those of actual flight conditions. No planetarium-type star presentations are required, consequently the equipment may be set up in any convenient classroom.

Type III magnetic servo amplifiers utilize ac, dc or pulse input signals with 115 v 60 cps excitation to produce a reversible (polarity sensitive) output of 30 v from a 1 v input, up to a 70 v output from a 2.25 v input. Because high efficiency is realized by the Type III amplifier and because heat-generating tubes are not used, it can operate over an ambient temperature range from -60° to 150°F. Many military and commercial applications are seen for this device in addition to its use in the training devices now being manufactured by *The Reflectone Corporation, Stamford, Conn.*, for the Navy, Air Force, Marines and commercial airlines.

For more information circle 281 on inquiry card.

Manually-Operated Auto-Bridge Speeds Inspection Tests



FIG. 1. NON-TECHNICAL operator uses Auto-Bridge.

In many component testing operations the numbers involved are too few or the product too subject to change to justify tooling for full automation. At the same time the skills and time involved in conventional component testing procedures become a major cost factor. Limit testing of components being incorporated in military production is being increasingly required for greater reliability of completed systems. In such testing applications, the new AB-3X2 manual-feed, manual-sort Auto-Bridge is designed for flexibility in use and enables rapid accurate testing by non-technical operators.

The Auto-Bridge tests many types and sizes of electronic components, requiring only a few seconds to accomplish the required setup changes, and is suitable for tests on resistors, condensers, inductances or com-

binations. Subassemblies and wired circuits can be compared where the impedance falls within the instrument range. Plug-in standards facilitate the accurate and positive setting of tolerance limits.

In operation, the inspector places the component being tested in the test clips. As she withdraws her hand, she rests it on a treadle that switches ratio arms in a true limit bridge circuit. If the red light comes on, the unit is outside the preset tolerance. If the green light burns, the unit is within tolerance.

Gain variations in vacuum tubes have only a second-order effect on test accuracy and no calibration or periodic checks are required. Accuracies of $\pm 0.3\%$ are claimed on capacities in the 100 μf to 15 μf range, on resistances from 10 ohms to 5 megohms, and impedances from 10 ohms to 5 megohms, at practical operating speeds of 1500 pieces per hour. The AB-3X2 Auto-Bridge is a development of Industrial Instruments Inc., 89 Commerce Rd., Cedar Grove, N. J.

For more information circle 282 on inquiry card.

Inspection Equipment Uses Cold Light

New inspection equipment for inaccessible spaces in missiles and airplane wings as well as in the medical field consists of (1) a powerful lamp assembly (Fig. 1) arranged to deliver its light without accompanying heat into confined spaces through a quartz rod, and (2) a right-angle telescope.

The lamp assembly is contained within an aluminum housing and uses 50-candlepower 6-8 v pre-focused lamp which has its output concentrated by a lens and mirror system into the near end of a quartz rod. The beam of light is then conducted down the rod and out the far end through a prism and lens system. The light as delivered from the lamp housing to the quartz is filtered with heat-absorbing glass placed between the condensing lens.

The light delivered is of the quality best suited to color photography. At a distance of 12" from the rod 14 ft-candles of illumination is delivered with six volts applied to the lamp, and 28 ft-candles with 8 volts to the lamp.

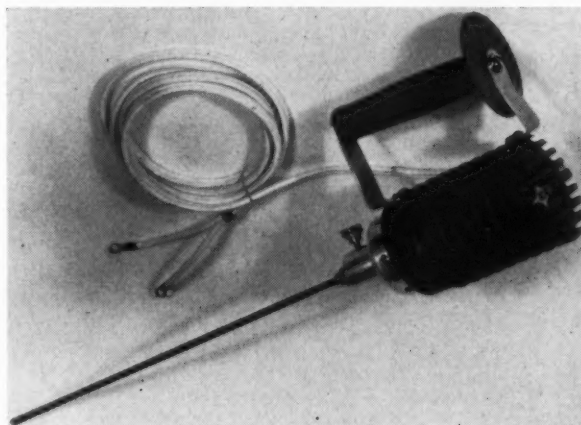


FIG. 1. SIX-VOLT lamp assembly delivers cold light at angle from end of quartz rod.

After prolonged operation at 8 volts, the housing will rise to 235°F. With normal use and safeguards, this temperature is safe to use in an area where the flash point of liquids or solids is not less than 350°F. A separate low-voltage transformer is provided to supply filament voltage to the lamp. The primary is rated at 115 v, 50-60 cps. The secondary is tapped at 6, 7, and 8 volts, with the 6-v step used for normal viewing and other steps used for more brilliant illumination when required.

The telescope used has an O.D. of only 0.189" and the working length from the shoulder of the eyepiece to the center line of the exit prism is 12 1/4". The length and diameter of a scope may be varied to meet the needs of specific demands. The scope can be focused sharply to view objects from 6 to 45 inches with a narrow angle of vision to obtain good magnifications.

This inspection aid is a product of Plummer & Kershaw, 2759 Frankford Ave., Philadelphia, Pa.

For more information circle 283 on inquiry card.

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INSTRUMENTS TEST EQUIPMENT

ELECTRONIC TEST EQUIPMENT is described in new 28-page catalog No. 36.—The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.

Circle 284 on inquiry card.

TIMING CLOCKS for laboratory, appliance and other uses have specs in new 2-page Form No. 161.—Lux Clock Mfg. Co., Inc., 95 Johnson St. Waterbury 20, Conn.

Circle 285 on inquiry card.

SIMULATED INSTRUMENTS for flight trainers and facilities for special design problems are subject of new 4-page facilities brochure.—Midway Aircraft Inst. Corp., 185 Berger St., Wood-Ridge, N. J.

Circle 286 on inquiry card.

LO-FREQUENCY NOISE generator, Model 401, for simulation of random

quantities from zero to 35 cps in analog computer analysis and design of complex systems, is described in 2-page technical data sheet 119.—Reeves Instrument Corp., 215 E. 91 St., New York 28, N. Y.

Circle 287 on inquiry card.

RADAR TARGET SIMULATOR, Model RP 375, supplying multiple targets for evaluation and testing of radar systems is described in new 4-page brochure.—Remanco, Inc., 128 Broadway, Santa Monica, Calif.

Circle 288 on inquiry card.

MICROWAVE MEASUREMENT techniques and equipment are explained in new 34-page catalog No. 58.—Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

Circle 289 on inquiry card.

AC MINIATURE MOTORS and gear reducers are listed with specs in new 10-page catalog.—Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 290 on inquiry card.

SYNCHRO DATA CHARTS: One defines parameters on synchro data sheets, other designates windings at which null voltages may be found.—Theta Instrument Corp., 48 Pine St., East Paterson, N. J.

Circle 291 on inquiry card.

TEST TABLE for three-axis checking of gyros is explained in 2-page Data sheet 113-4.—Lear, Grand Rapids Div., 110 Ionia Ave., N. W., Grand Rapids 2, Mich.

Circle 292 on inquiry card.

MANOMETERS for aerodynamic and engine tests are described in 4-page catalog No. 206.—Dynametrics Corp., Northwest Industrial Park, Burlington, Mass.

Circle 293 on inquiry card.

DISTANCE DETECTOR transducer is explained in new 2-page bulletin No. 15.—Bently Scientific Co., 2811 7 St., Berkeley 10, Calif.

Circle 294 on inquiry card.

MECHANICAL TESTING of missile and aircraft structures through rapid loading control systems is explained in new 4-page bulletin V-4006.—CDC Control Services, Inc., 637 S. Warminster Rd., Hatboro, Pa.

Circle 295 on inquiry card.

SERVOS, MOTORS POWER SYSTEMS

SYNCHRO AND ROTARY COMPONENT electrical and mechanical characteristics and design data are given in new 20-page catalog.—Clifton Precision Products Co., Inc., Clifton Heights, Penna.

Circle 296 on inquiry card.

REMOTE CONTROL SERVO system, Electrolink 60, for industrial applications and using 60 cps components, is described in new 4-page brochure.—Lear, Grand Rapids Div., 110 Ionia Ave., N. W., Grand Rapids 2, Mich.

Circle 297 on inquiry card.

400 CPS MOTOR-GENERATORS mounted on dollies and providing 1/2 to 250 kw outputs, powered from dc or any commercial ac frequency are described in new 2-page data sheet.—Dept-43-E, Kato Eng. Co., Mankato, Minn.

Circle 298 on inquiry card.

GROUND POWER SYSTEM for missiles and aircraft providing 15 kva, 400 cps synchronized with external source is described in 5-page Mod. 2615 data sheets.—Varo Mfg. Co., Inc., 2201 Walnut St., Garland, Tex.

Circle 299 on inquiry card.

VOLTAGE REGULATOR that corrects waveforms in 1.4 kv 400 cps output has operation described in new 4-page brochure.—Curtis-Wright Electronics Division, Carlstadt, N. J.

Circle 300 on inquiry card.

SERVO KITS, their use in training and experimental servo development with servo theory and description of all components, are explained in new 52-page catalog.—Mechatrol Div., Servomechanisms, Inc., 1200 Prospect Ave., Westbury, L. I., N. Y.

Circle 301 on inquiry card.

AUTOMATIC VOLTAGE REGULATORS from 2 to 100 kva output, in single- and three-phase duty, 50/60 cps, are described in new 12-page bulletin S358EMT.—The Superior Electric Co., Bristol, Conn.

Circle 302 on inquiry card.

GROUND POWER SYSTEMS, 16-page brochure describes five new 400-cycle motor-clutch-generator sets with power outputs of 1.5 to 15 kva.—Varo Mfg. Co., 2201 Walnut St., Garland, Texas.

Circle 303 on inquiry card.

CABLES, CONNECTORS

QUICK CONNECT-DISCONNECT hose couplings for guided missile and aircraft uses are described in new 26-page catalog.—Snap-Tite, Inc., Union City, Pa.

Circle 304 on inquiry card.

MULTIPLE HEADERS and plugs with hermetic glass-to-metal bonds; engineering specs are given in 16-page catalog No. 657-A.—Hermetic Seal Corp., 29 S. 6 St., Newark 7, N. J.

Circle 305 on inquiry card.

FLEXIBLE WIRING CONDUIT providing protection to electrical circuits from oils, acids, alcohols and hydrocarbons to 220°F is described in new 2-page data sheet.—Electri-Flex Co., Roselle, Ill.

Circle 306 on inquiry card.

TEFLON INSULATED wire and cables are listed in new 2-page bulletin.—Thermax Wire Corp., 304 E 45 St., New York 17, N. Y.

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SUB-MIN TERMINALS. Teflon stand-offs, feed-thrus, probes and plugs are listed in new 8-page catalog.—Trin-seel Inc., Div. of Tri-Point Plastics, Inc., 177 I. U. Willetts Rd., Albertson, L. I., N. Y.

Circle 308 on inquiry card.

FLEXIBLE METAL HOSE and tubing types and applications are described in new 38-page Penflex catalog.—Pennsylvania Flexible Metallic Tubing Co., Inc., 7200 Powers Lane, Philadelphia, Pa.

Circle 309 on inquiry card.

CONNECTOR SOLDERING techniques for better reliability is subject of new 10-page report on soldering of miniature connectors.—The Deutsch Co., 7000 S. Avalon Blvd., Los Angeles 3, Calif.

Circle 310 on inquiry card.

MINIATURE switches, rotary tap switches, and binding posts are listed in new 8-page condensed catalog M202.—Grayhill, Inc., 561 Hillgrove Ave., LaGrange, Ill.

Circle 311 on inquiry card.

ELECTRONIC COMPONENTS

MAG AMP, TRANSFORMER AND FILTER COMPONENTS are listed in new 48-page catalog No. 581.—Freed Transformer Co., Inc., 1714 Weirfield St., Brooklyn 27, N. Y.

Circle 312 on inquiry card.

COMPUTER GRADE Alumalytic capacitors designed for high reliability and long operating life are described in new 6-page bulletin GEA-6819.—General Electric Co., Schenectady 5, N. Y.

Circle 313 on inquiry card.

MINIATURIZED MAGNETIC MODULATORS for control and data system design are described with characteristic curves in new 4-page bulletin.—General Magnetics, Inc., 135 Bloomfield Ave., Bloomfield, N. J.

Circle 314 on inquiry card.

TEMPERATURE CONTROLS for aircraft covering on-off, proportioning and pulse-modulated floating types are described in new 2-page data sheet F-8537.—Barber-Colman Co., Aircraft Controls Div., 1300 Rock St., Rockford, Ill.

Circle 315 on inquiry card.

WAVE GUIDE COMPONENTS for large-size waveguide are described in new 4-page catalog.—D. S. Kennedy & Co., Cohasset, Mass.

Circle 316 on inquiry card.

LARGE ANTENNAS for radar, scatter communications, missile tracking and radio astronomy are featured in new 4-page catalog.—D. S. Kennedy & Co., Cohasset, Mass.

Circle 317 on inquiry card.

IF AMPLIFIERS for radar and guided missile applications are described in new 14-page 1958 catalog.—LEL, Inc., 380 Oak St., Copiague, L. I., N. Y.

Circle 318 on inquiry card.

MICROWAVE FERRITE COMPONENTS are listed in new 4-page short-form catalog, Cascade Research Div., Monogram Precision Industries, Inc., Los Gatos, Calif.

Circle 319 on inquiry card.

LINEAR ACTUATORS for missiles and aircraft are described in 2-page data sheets: Series 313 (400 lbs load), series 413 (500 lbs) and series 435 (4,500 lbs)—Lear, 110 Ionia Ave., N. W., Grand Rapids 2, Mich.

Circle 320 on inquiry card.

SUBMINIATURE NEON lamp with integral ballast for 115v ac is described in new 2-page datasheet NE2R.—Circon Component Corp., Santa Barbara/Goleta, Calif.

Circle 321 on inquiry card.

MINI POTS meeting Mil-Specs in three sizes are described in New 4-page type "E" catalog.—Waters Mfg., Inc., Wayland, Mass.

Circle 322 on inquiry card.

ELECTRONIC CONTROLS and components are listed in new 108-page catalog No. 58-4.—Electro Sales Co., Inc., 50-58 Eastern Ave., Boston 9, Mass.

Circle 323 on inquiry card.

ACCELEROMETER APPLICATIONS and calibration techniques are explained in new 24-page Series 2200 Instruction Manual.—Endevco Corp., 161 East California St., Pasadena, Calif.

Circle 324 on inquiry card.

PRECISION POTS in the Micropot Series, Micordials, and instrument motors are listed in 28-page catalog No. BED-A90.—Borg Equipment Div., The George W. Borg Corp., 120 S. Main St., Janesville, Wisc.

Circle 325 on inquiry card.

INSTANTANEOUS ELECTRONIC and Tubeless Magnetic automatic voltage regulators are described in 2-page catalog sheet.—The Superior Electric Co., Bristol, Conn.

Circle 326 on inquiry card.

THERMISTOR AND VARISTOR terminology, characteristics and specs are described in new 10-page catalog V282.—Victory Engineering Corp., Springfield Rd., Union, N. J.

Circle 327 on inquiry card.

VARIABLE RESISTORS, wirewound and composition types certified to latest Mil-Specs are listed on new stock sheet No. 164.—Chicago Telephone Supply Corp., Elkhart, Ind.

Circle 328 on inquiry card.

SUBMINIATURE LC BANDPASS filters using new "egg-crate" design are explained in new 4-page brochure.—The Daven Co., Livingston, N. J.

Circle 329 on inquiry card.

PRECISION DEFLECTION systems and components for radar and other cathode ray applications are described in new 6-page brochure Form 3R 3295.—Ind. and Audio Products Dept., Radio Corporation of America, Camden, N. J.

Circle 330 on inquiry card.

RADIO INTERFERENCE FILTER specifications data are given in 4-page catalog.—All-Tronics Inc., 45 Bond St., Waterbury, L. I., N. Y.

Circle 331 on inquiry card.

PRECISION BOBBINLESS WIRE RESISTORS specifications are given in new 2-page data sheet No. 171.—Chicago Telephone Supply Corp., Elkhart, Ind.

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STANDARD DELAY LINES in 500 to 2000 ohms with delays to 1 microsecond are listed in new 2-page data sheet No. 140.—NYT Electronics, Inc., 2979 N. Ontario St., Burbank, Calif.

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BINARY FREQUENCY DIVIDER is explained in new 2-page bulletin No. 56.—Rixon Electronics, Inc., 2414 Reddie Dr., Silver Spring, Md.

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HI-VOLTAGE HI-CAPACITY condensers in metal and glass containers and for exceeding MIL-C-25A specs are explained in new XMP and GMP data sheets.—The Potter Co., 1950 Sheridan Rd., N. Chicago, Ill.

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COMPUTERS

PULSE CODE DATA TRANSMISSION is described in new 4-page bulletin CP-3701.—The Vapor Recovery Systems Co., 2820 N. Alameda, Compton, Calif.

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HIGH-SPEED BINARY DATA transmission over narrow frequency-band links by new Kineplex Predicted Wave Signalling System is explained in new 24-page bulletin C-109-56.—Collins Radio Co., 315 Second Ave., Cedar Rapids, Iowa.

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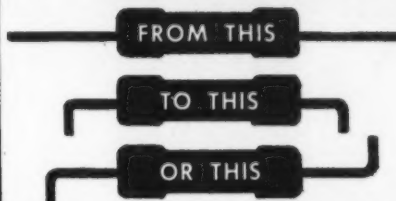
SUMMING AMPLIFIER Model 410 data and applications for missile guidance, telemetering, etc., are given in 2-page data sheet.—Acromag, Inc., 22519 Telegraph Road, Detroit 41, Mich.

Circle 338 on inquiry card.

SIMPLIFIED PROGRAMMING techniques for G-15 general purpose digital computer are explained in new 6-page bulletin No. AB-116.—Bendix Computer Div., Bendix Aviation Corp., 5630 Arbor Vitae St., Los Angeles 45, Calif.

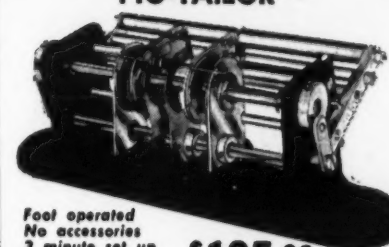
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July 14-25

Special Summer Program in the Physics of Infrared Radiation, Massachusetts Institute of Technology. Write Dr. Richard C. Lord, Dir. of Spectroscopy Laboratory, M. I. T., Cambridge, Mass.

July 24-25

5th Annual Symposium on Computers and Data Processing sponsored by the Electronics Div., Denver Research Institute, University of Denver, at Albany Hotel, Denver, Colo. Write C. A. Hedberg, Head Electronics Div., Denver Research Institute, U. of Denver, Denver 10, Colo.

July 29-31

3rd Annual Exhiborama and 2nd Annual Symposium, Society of Photographic Instrumentation Engineers, at Statler Hotel, Los Angeles. Write Bob Jakobsen, Jakobsen Advertising Agency, Inc., 2201 Park Drive, Los Angeles 26, Calif.

August 6-8

Special Technical Conference on Non-Linear Magnetism sponsored by the AIEE, Hotel Statler, Los Angeles, Calif. Write Special Technical Conference, Box 2025, Downey, Calif.

August 13-15

Conference on Electronic Standards and Measurements co-sponsored by AIEE, and Natl. Bu. of Standards, Boulder, Colorado. Write James F. Brockman, Boulder Labs., Natl. Bu. of Standards, Boulder, Colorado.

August 19-22

WESCON (Western Electronics Show and Convention) co-sponsored by the San Francisco and Los Angeles sections of IRE and the West Coast Electronic Mfg. Assn., Pan Pacific Auditorium and Ambassador Hotel, Los Angeles, Calif. Write Ted Shields, General Public Relations, Inc., 607 S. Hobart Blvd., Los Angeles 5, Calif.

September 1-5

2nd International Conference, The International Assn. for Analog Computations, Strasbourg, France. Write F. H. Raymond c/o S.E.A., 138 Blvd de Verdun, Courbevoie (Seine), France.

September 3-5

Cryogenic Engineering Conference, Massachusetts Institute of Technology. Write K. D. Timmerhaus, Dept. Chemical Engineering, University of Colorado, Boulder, Colorado.

September 8-13

1st Int. Congress of the Aeronautical Sciences planned by the International Council of the Aeronautical Sciences, Madrid, Spain. Write Institute of Aeronautical Sciences, 2 East 64th Street, New York 21, N. Y.

September 24-25

7th Annual Symposium on Indust. Electronics of the IRE, Rackham Memorial Auditorium, Detroit, Mich., Write Wm. R. Thurston, IRE Prof. Grp. on Indust. Electronics, General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

New Literature—CONT.

FACILITIES & ENVIRONMENTAL TESTS

PLASMA DYNAMICS, hypersonics and space technology research activities of the G-E Missile and Ordnance Systems Aerodynamics Lab. are described in new 18-page facilities booklet.—Missile and Ordnance Systems Dept., Room 5A, General Electric Co., 3198 Chestnut St., Philadelphia 4, Pa.

Circle 340 on inquiry card.

LOX OR GASEOUS OXYGEN and nitrogen testing of aircraft/missile components at new Norco Cryogenic Facility is explained in 4-page facility brochure.—Wyle Associates, 128 Maryland St., El Segundo, Calif.

Circle 341 on inquiry card.

MISSILE SYSTEMS and other military systems activities of the Ordnance Division, M-H Regulator Co., are explained in new 16-page facilities booklet.—Ordnance Div., Minneapolis-Honeywell Regulator Co., 600 Second St. N., Hopkins, Minn.

Circle 342 on inquiry card.

HIGH-TEMPERATURE EQUIPMENT DESIGN programs and progress are described in new 4-page bulletin, MPB-32.—Missile Production Sec., General Electric Co., Lakeside Ave., Burlington, Vt.

Circle 343 on inquiry card.

GUIDED MISSILES of all types are listed by name, prime contractors and component sub-contractors in free new 8-page data sheet.—W. E. Schneider, LaSalle Steel Co., P. O. Box 6800A, Chicago 80, Ill.

Circle 344 on inquiry card.

ELECTRO-HYDRAULIC SYSTEMS engineering capabilities and components are described in new 4-page facilities brochure.—Sanders Associates, Inc., Nashua, N. H.

Circle 345 on inquiry card.

PRECISION PART and electro-mechanical assembly custom production is explained in 6-page facilities folder.—Superior Mfg. and Instrument Corp., 154-01 Barclay Ave., Flushing 55, N. Y.

Circle 346 on inquiry card.

INFRARED, OPTICS

SCOPE-RECORDING PERISCOPE, explained in 2-page data sheet Traid 450.—Traid Corp., 17136 Ventura Blvd., Encino, Calif.

Circle 347 on inquiry card.

INFRARED TRANSMISSION Spectra on eleven materials, physical characteristics on fifteen, are given in new 4-page brochure.—Servo Corp. of America, 20-20 Jericho Tpk., New Hyde Park, N. Y.

Circle 348 on inquiry card.

UNITIZED MICROFILM SYSTEM for quantity reproduction of low-cost, high quality engineering drawings is explained in new 5-page brochure featuring Artybasheff drawing of the XeroX Copyflo 24.—Haloid XeroX, Inc., X-281 Haloid St., Rochester 3, N. Y.

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CLEAR SAPPHIRE THERMAL properties are listed with data curves in new 7-page Industrial Crystals bulletin No. 6.—Linde Air Products Co., 30 E. 42 St., New York 17, N. Y.

Circle 350 on inquiry card.

PHOTO-OPTICAL EQUIPMENT and supplies are listed in new 124-page catalog.—Burke & James, Inc., 321 S. Wabash Ave., Chicago 4, Ill.

Circle 351 on inquiry card.

TUBES, TRANSISTORS

KLYSTRON FACTS, CASE FIVE gives new information on power klystron applications in new 20-page brochure.—Eitel-McCullough Inc., San Bruno, Calif.

Circle 352 on inquiry card.

GEMANUM ALLOY junction transistors, types 2N43 and 2N44, are described with performance graphs in new 4-page brochure, ECG-292.—General Electric Co., Semiconductor Prod. Dept., Syracuse 1, N. Y.

Circle 353 on inquiry card.

SILICON JUNCTION DIODES, zener diodes, glass diodes, zener reference units, power regulators and silicon solar cells have specs listed in 6-page bulletin HSD-1-458.—Hoffman Electronics Corp., Semiconductor Div., 930 Pitner Ave., Evanston, Ill.

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ARC BLOCKING AND SUPPRESSING with selenium rectifiers in relay circuits is explained in 4-page folder.—Bradley Laboratories, Inc., New Haven 11, Conn.

Circle 355 on inquiry card.

DIFFUSED JUNCTION SILICON, selenium and copper oxide rectifiers are described in new 4-page folder.—Bradley Laboratories, Inc., New Haven 11, Conn.

Circle 356 on inquiry card.

DIFFUSED JUNCTION SILICON power diodes characteristics for -65° to 150°C operation at 10-30 amp, 35-238 v rms loads are given in five engineering data sheets.—Thermosen, Inc., 375 Fairfield Ave., Stamford, Conn.

Circle 357 on inquiry card.

POWER TRANSISTOR Characteristic Plotter Model 341 is described in 2-page data sheet.—Dunn Eng. Assoc., Inc., 225 O'Brien Hwy., Cambridge 41, Mass.

Circle 358 on inquiry card.

MISCELLANEOUS

ENCAPSULATING PREFORMS of Epoxweld 100 are described in 2-page bulletin No. 114.—Duramic Products, Inc., 262-72 Mott St., New York 12, N. Y.

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EPOXY PREFORMS (pressed shapes) used in automatic or production assemblies are described in 2-page bulletin 114.—Duramic Products, Inc., 262-72 Mott St., New York 12, N. Y.

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LEAD-FORMS with oxygen-free wire leads to aid in encapsulation of miniature and subminiature components are explained in new 1-page data sheet.—A-1 Precision Products, 3622 W. Jefferson Blvd., Los Angeles 16, Calif.

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EPOXY ENCAPSULATION service now available to electronic industry is explained in new 2-page brochure.—Plastronic Engineering Co., 721 Boston Post Rd., Marlborough, Mass.

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VALVES FOR AIRCRAFT AND MISSILES, custom-designed and built for lightest weight and size, are described in new 2-page data sheet.—Bodnar and McDermott Mfg. Co., Inc., 19 Beechwood Ave., Mt. Vernon, N. Y.

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SLEEVING AND TUBING in teflon, plastic and fiberglass types are described in 20-page catalog T-58.—Birnback Radio Co., Inc., 145 Hudson St., New York 13, N. Y.

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WOOD LABORATORY desks, tables, fume hoods, etc., for schools or industrial laboratories with suggested floor plans, are described in new 84-page catalog.—Metalab-Labcraft Div., Norbute Corp., 224 Duffy Ave., Hicksville, L. I., N. Y.

Circle 365 on inquiry card.

PERIPHERAL MARKING MACHINES for hot stamping of calibrations and other markings are described in new 6-page catalog 9A.—The Acromark Co., 9-13 Morrell St., Elizabeth 4, N. J.

Circle 366 on inquiry card.

LOW TEMPERATURE CONVERSION table covering degrees Celsius, Fahrenheit, and Kelvin from absolute zero to 0°C is available on request.—Technical Sales Dept., Trans-Sonics, Inc., Burlington, Mass.

Circle 367 on inquiry card.

MECHANICAL SPRINGS of all types are described in 8-page booklet.—Superb Spring Works, Inc., 34A E. Sidney Ave., Mt. Vernon, N. Y.

Circle 368 on inquiry card.

PROPELLANT ACTUATED DEVICES are listed for six functions in new 4-page brochure.—Beckman & Whitely, Inc., 985 San Carlos Ave., San Carlos, Calif.

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